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 for Second Year B. Tech. in Civil Engineering with Multidisciplinary Minor
To be implemented for 2024-28 Batch
(With Effect from Academic Year 2025-26)

MDM Syllabus Offered by Civil Engineering for Other Branch Students for SEM III and SEM IV

24-MDM-CE-2-01: Fundamentals of Green Technology

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

Prerequisite Course: 24-ESC-1-04**:**Smart Building and Materials

Companion Course: 24-MDM-CE-2-02:Fundamentals of Green Technology Lab

Course Objectives:

- To introduce the concept of Green Technology.
- To learn the importance of Green Fuels and its impact on the environment.
- To learn renewable energy sources and its suitability.

Course Outcomes:

After completion of the course, learners should be able to

CO No	**CO**	**BL**
CO1	**Understand** the concept of green technology.	2
CO2	**Demonstrate** the concept of a clean development mechanism.	3
CO3	**Discuss** the importance of green fuels and its impact on the environment.	2
CO4	**Explain** sustainable construction using industrial by-products, geopolymer concrete, PCMs, self-healing, and smart materials	2

Course Contents

Unit I	**Green technology**	**6 Hours**

Introduction to green technology: Concept of green technology; definition, importance, history and evolution of green technology; advantages and limitations ,factors affecting green technologies; Role of industry, government and institutions in green technology.

#Exemplar/Case Studies: Bengaluru International Airport (Kempegowda International Airport) – Green Airport Initiatives

***Mapping of Course Outcomes**	CO1

Unit II	**Cleaner Production**	**6 Hours**

Cleaner Production (CP): Concept of cleaner production; definition, importance, principles, benefits of cleaner Production; Role of industry, government and institutions in cleaner production, clean development mechanism.

#Exemplar/Case Studies:–The Nathpa Jhakri Hydroelectric Project in India.		
***Mapping of Course Outcomes**	CO2	
Unit III	**Green fuels**	**6 Hours**
Green fuels: Concept of green fuels; definition, benefits, challenges. Comparison of green fuels with conventional fossil fuels with reference to environmental, economic and social impacts.		
#Exemplar/Case Studies:–Ethanol Production from Sugarcane in Maharashtra, India		
***Mapping of Course Outcomes**	CO3	
Unit IV	**Industrial By-products as Green Materials**	**6 Hours**
Industrial By-products as Green Materials: Fly ash, silica fume, slag, Properties and applications in concrete and cementitious materials, geopolymer concrete, phase change materials (PCMs) Self-healing concrete and smart materials for sustainable construction		
#Exemplar/Case Studies:–Case studies on green materials such as bamboo reinforced concrete.		
***Mapping of Course Outcomes**	CO4	
Learning Resources		
Text Books		
T1. Air Pollution - the effect of air pollution Volume 2,Sturn Arthur, Academic Press; 2006 **T2.** Pollution Prevention and Abatment Handbook-Towards Cleaner Production,World bank Group,World Bank and UNEP,Washington D.C.,1998 **T3.** Prasad Modak,C.Visvanathan and Mandar Parasnis,Cleaner Production Audit,Enviornmental System revies,No,38,Asian institute of Technology,Bangkok,1995		
Reference Books :		
R1. Renewable Energy Sources and Emerging Technologies by D.P. Kothari and K.C. Singal		
Additional Resources: (Books, e-Resources) 1. https://www.wipo.int/edocs/pubdocs/en/wipo-pub-1080-en-green-technology-book.pdf		
MOOC Courses links : ● https://onlinecourses.swayam2.ac.in/ugc25_ge08/preview		

24-MDM-CE-2-02: Fundamentals of Green Technology Lab

Teaching Scheme:	**Credit:** 01	**Examination Scheme:**
Practical: 02 Hours/Week		**Termwork (TW)** : 25 Marks **Oral**: 25 Marks

Prerequisite Course: 24-ESC-1-04**:** Smart Building and Materials Lab

Companion Course: 24-MDM-CE-2-02**:** Fundamentals of Green Technology

Course Objectives:

- To introduce the detailed concept of green technology and various sources of energy as alternatives to conventional once.

Course Outcomes:

After completion of the course, learners should be able to

CO No	CO	BL
CO1	**Explain** green technology, industrial ecology, and cleaner production.	2
CO2	**Use of** green fuels, carbon trading, and waste-to-wealth concepts.	3
CO3	**Apply** biomass energy and sustainable engineering solutions.	3
CO4	**Conduct** tests to assess the performance of geopolymer and heat-resistant concrete for sustainable construction.	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, 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.

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 and punctuality.

Guidelines for Practical / Oral Examination

Problem statements must be decided jointly by the internal examiner and external examiner. During the practical/oral 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

- Understand the objectives of the experiment.
- Keep your workspace organized and tidy.
- Record observations and data meticulously.
- Report any damaged or malfunctioning equipment immediately.
- Report accidents, spills, or injuries immediately.
- Analyze and review experiment results accurately.
- Follow institutional and regulatory guidelines.

Virtual Laboratory: (If Any):

Suggested List of Laboratory Experiments/Assignments

Group A: Assignments (Mandatory Assignment)

Sr No	Assignment Title	*Mapping of Course Outcomes
1.	Definition of Green Technology, its Importance and advantages and disadvantages.	CO1
2.	Role of industrial ecology in green technology.	CO1
3.	Principles of Cleaner Production and its Benefits.	CO1
4.	Green Fuels, their benefits and challenges.	CO2

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

Sr No	Assignment Title	*Mapping of Course Outcomes
1.	Clean development mechanism, Wealth from waste.	CO1
2.	Carbon credit and carbon trading.	CO2
3.	Strength Test of Geopolymer Concrete.	CO4

Group C: Assignments (if Any) <<Mini Project/Field Visit Etc>>

Sr No	Assignment Title	*Mapping of Course Outcomes
1.	Self-Healing Concrete Experiment.	CO4
2.	Concept of biomass energy utilization, types of biomass.	CO3
3.	Heat-Resistant Concrete Using Phase Change Materials (PCMs).	CO4

Learning Resources (If applicable)

T1. Air Pollution - the effect of air pollution Volume 2,Sturn Arthur, Academic Press; 2006
T2. Pollution Prevention and Abatment Handbook-Towards Cleaner Production,World bank Group,World Bank and UNEP,Washington D.C.,1998
T3. Prasad Modak,C.Visvanathan and Mandar Parasnis,Cleaner Production Audit,Environmental System revies,No,38,Asian institute of Technology,Bangkok,1995

Reference Books :

R1. Renewable Energy Sources and Emerging Technologies by D.P. Kothari and K.C. Singal

Additional Resources: (Books, e-Resources)

- https://www.wipo.int/edocs/pubdocs/en/wipo-pub-1080-en-green-technology-book.pdf

MOOC Courses links :

- https://onlinecourses.swayam2.ac.in/ugc25_ge08/preview
- https://archive.nptel.ac.in/courses/103/107/103107157/

24-MDM-CE-2-03: Green Building Rating System

Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 3	**Examination Scheme:** **CIE** : 20 Marks **MSE :** 20 Marks **SEE** : 60 Marks

Prerequisite Courses: 24-MDM-CE-2-01: Fundamentals of Green Technology,
24-VEC-2-02: Environmental Science

Companion Course: -

Course Objectives:

- To study the principles of green building and sustainability.
- To demonstrate the different LEED credit categories and their applications and BREEAM assessment.
- To Study the energy-efficient technologies in building design.
- Identify the challenges in certifying green buildings and strategies to overcome them.

Course Outcomes:

After completion of the course, learners should be able to

CO No	CO	BL
1	**Understand** the principles of green building and sustainability	2
2	**Identify** the advantages of using rating systems in promoting sustainable construction.	2
3	**Demonstrate** an understanding of the different LEED credit categories and their applications.	3
4	**Apply** the categories in BREEAM assessment.	3
5	**Apply** knowledge of energy-efficient technologies in building design	3
6	**Identify** the challenges in certifying green buildings and strategies to overcome them.	2

Course Contents

Unit I	**Introduction to Green Building**	**7 Hours**

Overview of Green Building Concepts -Definition and principles of green building, Importance of sustainability in construction, Global environmental concerns: climate change, resource depletion, pollution, Sustainable Development Goals (SDGs), Key Components of Sustainable Buildings - Site selection, energy efficiency, water conservation, indoor air quality, material selection, waste management, Green Building vs. Conventional Building		
#Exemplar/Case Studies : Green Building Technology used in the new parliament of India**.**		
***Mapping of Course Outcomes**	**CO1**	
Unit II	**Green Building Rating Systems**	**7 Hours**
Introduction to Rating Systems, Key Global Rating Systems - LEED (Leadership in Energy and Environmental Design) - Overview and categories, BREEAM (Building Research Establishment Environmental Assessment Method), Other systems: DGNB (Germany), HQE (France), etc., Comparison of Different Rating Systems.		
#Exemplar/Case Studies: Case study on Pune Municipal Corporation Building (Pune), Surat Diamond Bourse (Surat) etc		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**LEED Rating System**	**7 Hours**
LEED Certification Process - Categories and prerequisites (Energy and Atmosphere, Indoor Environmental Quality, etc.), Points system and achieving certification (Certified, Silver, Gold, Platinum) LEED Credit Categories - Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation in Design, Application of LEED for Various Building Types- Commercial, Residential, and Industrial buildings		
#Exemplar/Case Studies : The National Institute of Solar Energy (NISE), Gurugram and State Secretariat Building, Gujarat		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**BREEAM Rating System**	**8 Hours**
BREEAM Certification Process - Assessment and evaluation of buildings, Categories in BREEAM (Management, Health & Well-being, Energy, Transport, Water, Materials, Waste, Land use & ecology, Pollution), BREEAM Assessment Methods, BREEAM vs. LEED: A Comparative Study		
#Exemplar/Case Studies : The National Centre for the Performing Arts (NCPA) – Mumbai		
***Mapping of Course Outcomes**	**CO4**	
Unit V	**Green Building Technologies and Innovations**	**8 Hours**

Building Energy Efficiency -Passive design principles (natural lighting, ventilation), Renewable energy technologies (solar, wind, geothermal), Water Conservation Technologies - Low-flow fixtures, rainwater harvesting, Greywater systems, Sustainable Materials and Waste Management -Use of recycled, low-impact, and locally sourced materials, Construction waste diversion and recycling, Indoor Environmental Quality - Ventilation systems, air quality, daylighting, and acoustic management		
#Exemplar/Case Studies: Case Study on the India Bulls Green Building(Mumbai), Neco Garden(Nashik) etc.		
***Mapping of Course Outcomes**	**CO5**	
Unit VI	**Implementing Green Building Rating Systems and Case Studies**	**8 Hours**
Process of Implementing a Green Building Rating System - Steps involved in certification: from design to post-occupancy, Cost considerations and ROI for green buildings Challenges in Green Building Certification - Technical, economic, and regulatory barriers, Overcoming challenges through design, policy, and education Future Trends in Green Building Design- Net-zero buildings, circular economy, and climate-responsive architecture		
#Exemplar/Case Studies: Case Study on Maharshtra Sadan (New Delhi) Indira Paryavaran Bhawan(New Delhi) etc.		
***Mapping of Course Outcomes**	**CO2,CO5**	
Learning Resources		
Text Books		
T1. Green Building and LEED Core Concepts Guide" by U.S. Green Building Council (USGBC) **T2.** "BREEAM: The Building Research Establishment Environmental Assessment Method" by Tom Woolley		
Reference Books :		
R1. "Sustainable Construction: Green Building Design and Delivery" by Charles J. Kibert **R2.** "The Green Building Revolution" by Jerry Yudelson		
Additional Resources: (Books, e-Resources) 1."Principles of Sustainable Energy Systems" by Frank Kreith and D. Yogi Goswami 2. ndl.ethernet.edu.et/bitstream/123456789/39984/1/138.pdf		
MOOC Courses links : •		

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24-MDM-CS-2-01: Data Structures

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

Prerequisites Courses: (24-ESC-1-06) Programming and Problem Solving using Python, (24-ESC-1-02) Programming and Problem Solving

Companion Course: (24-MDM-CS-2-02) Data Structure Laboratory

Course Objectives:
Understand and apply linear (arrays, stacks, queues) and nonlinear (trees, graphs) data structures to efficiently solve real-world problems.

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

CONo	Course Outcome	BL
CO1	**Understand** the core concepts of Data Structures.	2
CO2	**Apply** linear data structures to solve problems.	3
CO3	**Apply** non-linear data structures like trees and graphs in practical applications	3
CO4	**Solve** real-world applications using data structures	3

Course Contents

Unit I	**Introduction to Data Structure**	**7 Hours**

Data,Data type, ADT (Abstract Data Type), Data structure, Primitive and Non-primitive structures, Static and Dynamic, Persistent and Ephemeral data structures, Linear and non-linear data structures.

#Exemplar/Case Studies Amazon Product Data consists of structured attributes each with specific data types.

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

Unit II	**Linear Data Structures**	**8 Hours**

Overview of Array, Multidimensional arrays, Stack Concepts with Operations (Push, Pop, IsEmpty, IsFull) and Queue concepts with operations (Insert, Delete, IsEmpty, IsFull), basics of Linked List and its Types (Singly, Doubly, Circular).

#Exemplar/Case Studies Leaderboard Rankings systems using array, where player scores are stored and sorted to determine rankings.

***Mapping of Course Outcomes**	**CO1,CO2,CO4**

Unit III	**Non-Linear Data Structures**	**8 Hours**
Definition of the tree, Properties of the tree, Types of Trees: Binary Tree, Binary Search Tree (BST), Tree Traversals: Inorder, Preorder, Postorder, Definition of Graph, Terminology of graph, Adjacency Matrix, Graph Traversals: Depth First Search, Breadth First Search.		
#Exemplar/Case Studies: Instagram Network using graphs to represent users (nodes) and friends/follower (edges)		
***Mapping of Course Outcomes**	**CO1, CO3, CO4**	
Unit IV	**Applications of Data Structures**	**7 Hours**
Scheduling problem, N-Queens Problem as an example of an optimization system, Binary Space Partitioning Trees (BSP), Shortest Path (Dijkstra's Algorithm) for transportation Engineering, Minimum Spanning Tree (Prim's and Kruskal's Algorithm) for resource management and network optimization, Space complexity, Time complexity		
#Exemplar/Case Studies AlphaZero Chess Engines to find the shortest path for a pawn in chess.		
***Mapping of Course Outcomes**	**CO2,CO3,CO4**	

Learning Resources

Text Books:

T1. "Fundamentals of Data Structures in C++", E. Horowitz, S. Sahni, ,Second Edition, 2012, Galgotia Publication pvt ltd , ISBN 9780716782926
T2. "Data Structures and Algorithms in Python", Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser First Edition , 2021, New Delhi Wiley India; ISBN 978-1-118-29027-9

Reference Books :

R1. "Data Structure and Algorithms and Applications in C++", Sartaj Sahni, Second Edition, 2008, Universities Press, ISBN 978-81-317-0229-1
R2. "Let us Python", Yashwant Kanetkar & A. Kanetkar, Fourth Edition, 2022, BPB Publisher, ISBN: 978938984500

Additional Resources: (Books, e-Resources)

- https://ia801404.us.archive.org/2/items/cprogbooks/k%26r.pdf
- https://www.ebooks.com/en-us/book/95777110/Python-data-structures-and-algorithms/benjamin-baka/

MOOC Courses links :

- https://onlinecourses.nptel.ac.in/noc21_cs38/preview
- https://onlinecourses.swayam2.ac.in/cec22_cs20/preview

24-MDM-CS-2-02: Data Structures Laboratory

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

Prerequisites Courses: (24-ESC-1-07) Programming and Problem-Solving Lab,(24-ESC-1-10) Python Programming Lab

Companion Course: 24-MDM-CS-2-01 Data Structures

Course Objectives:

Implement and **operate** on linear data structures (arrays, stacks, queues, linked lists) and gain hands-on experience with non-linear data structures for solving real-world problems.

Course Outcomes:

After completion of the course, learners should be able to

CONo	Course Outcomes	BL
CO1	**Develop** practical skills in implementing linear data structures	3
CO2	**Implement** non-linear data structures like trees and graphs in practical applications	3
CO3	**Apply** appropriate Data Structures to solve real-world problems.	3
CO4	**Design & Implement** efficient solutions using appropriate data structures for electronics and Telecommunication applications.	3

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The instructor's manual is to be developed as a reference and hands-on resource. It should include a prologue (about the 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, 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. Google Drive Link containing student programs maintained by the Laboratory in charge is highly encouraged. For reference one or two journals may be kept with program prints in the Laboratory.

Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work should be based on the student's overall laboratory assignment performance. 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 ensure a strong and promising start to students' academic journey through our collective team efforts.

Guidelines for Laboratory Conduction

A list of laboratory assignments is provided below. The instructor must conduct 4 assignments from Group A and 4 assignments from Group B to meet the requirement of completing 8 practicals in total. Focus on writing custom logic to enhance understanding of fundamental concepts.

Requirement: Any open Source operating System, Vi-editor, Eclipse for Cpp Programming(E&TC)

Virtual Laboratory:

- https://cse01-iiith.vlabs.ac.in/List%20of%20experiments.html

Suggested List of Laboratory Experiments/Assignments

Group A: Assignments

Sr No	Assignment Title	*Mapping of Course Outcomes
1.	Create a program to input an array of integers (representing signal frequencies) and count the frequency of each unique frequency value. Display the frequency table which can be used for analyzing signal generator outputs.	CO1,CO3,CO4
2.	Write a program to maintain the marks of students in a data structure course. The system needs to: ● Calculate the average marks. ● Find the highest and lowest marks. ● Determine the number of students scoring above the average.	CO1,CO3
3.	Design a search system for an electronics lab that stores component records with unique Component IDs. Implement both Linear and Binary Search to find components based on their Component ID.	CO1,CO3,CO4
4.	Write the Bubble Sort algorithm to sort employee IDs in ascending order.	CO1,CO3
5.	Implement a function to reverse a given string using stack operations.	CO2,CO3
6.	Design a program to simulate the ticket queue at the theater. Implement a queue with the following operations: ● When a customer arrives, their name is added to the queue. ● Show all customers currently waiting in line. ● The first customer in the queue is served and removed from the queue.	CO2,CO3

Group B: Assignments

Sr No	Assignment Title	*Mapping of Course Outcomes

7.	Implement a program to create a binary search tree (BST) for the different branches of the Technical educational institute: Computer, Civil, AIDS, Mechanical, E&TC, and MBA. Implement the following operation: ● Insert branch names ● Display the branches	CO2,CO3,CO4
8.	Schedule n jobs with given deadlines and profits to maximize total profit, ensuring no two jobs overlap and each takes one unit of time. Find the optimal job sequence and maximum profit.	CO1, CO3
9.	Write a program with a recursive function for generating all possible configurations for the 4-queen's problem	CO1, CO3
10.	A telecommunications company has a network to connect cities with a communication line with a specific cost. The goal is to ensure that all cities are connected without forming cycles. Use Prim's or Kruskal's algorithm to find the Minimum Spanning Tree (MST)	CO2,CO3,CO4
11.	Implementation of Dijkstra's Algorithm for Finding Shortest Path.	CO2,CO3
12.	Write a program to implement a singly linked list for managing a E&TC Engineering book collection. Each node will represent a book with a Book ID and Title. Show operations: 1. Add a new book 2. Display all books	CO2,CO3,CO4

Text Books

T1. "Fundamentals of Data Structures in C++", E. Horowitz, S. Sahni, ,Second Edition, 2012, Galgotia Publication pvt ltd , ISBN 9780716782926

T2."Data Structures and Algorithms in C++",Adam Drozdeck, Third Edition, Cengage Learning, 2006, ISBN 13:978-81-315-0115-3, 10:81-315-0115-9

Reference Books :

R1. "Data Structure and Algorithms and Applications in C++", Sartaj Sahni, Second Edition, 2008, Universities Press, ISBN 978-81-317-0229-1

R2. "Data Structures and Algorithm Analysis in C++", Mark Allen Weiss, Third Edition, Pearson Education India, 2008, ISBN-978-81-317-14744

Additional Resources: (Books, e-Resources)

- https://ia801404.us.archive.org/2/items/cprogbooks/k%26r.pdf

MOOC Courses links :

- https://onlinecourses.nptel.ac.in/noc22_cs40/preview

24-MDM-CS-2-03: Database Management System

Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 03	**Examination Scheme:** **CIE**: 20 Marks **MSE:** 20 Marks **SEE**: 60 Marks

Prerequisites Courses: (24-MDM-CS-2-01) Data Structures

Companion Course: NA

Course Objectives:

- Understand database management, query languages, transaction processing, design approaches, parallel databases, and NoSQL concepts.

Course Outcomes:

After completion of the course, learners should be able to

CONo	Course Outcomes	BL
CO1	**Understand** the fundamentals and languages of database management systems.	2
CO2	**Design** efficient database systems to achieve optimized database schema.	3
CO3	**Implement** various database queries for structured and unstructured data.	3
CO4	**Apply** Transaction Management concepts in real-time situations.	3
CO5	**Understand** the concepts of parallel databases.	2

Course Contents

Unit I	**Introduction to Database Management Systems**	**7 Hours**

Introduction, Applications, Need, Views of data, Data Independence, Instances and schema, Database Languages, Database System Structure, Data Models, **Entity Relationship (ER) Model:** Entity, Attributes, Relationships, Cardinalities, Keys

#Exemplar/Case Studies: Design a database using the ER Model for library Management System

***Mapping of Course Outcomes**	**CO1,CO2**

Unit II	**Relational Database Design**	**07 Hours**

Relational Model: Basic Concepts, Attributes and Domains. **Integrity Constraints:** Entity, Domain, Referential, Enterprise. **Database Design:** Anomalies, **Normalization:** Functional Dependencies (FD), FD Closure, Attribute Closure, **Decomposition:** Lossy, Lossless Join, and dependency preservation, **Normal Forms:**1NF, 2NF, 3NF, BCNF.

#Exemplar/Case Studies: Normalize relational database designed in Unit I.

***Mapping of Course Outcomes**	**CO1,CO2**	
Unit III	**Structured Query Language(SQL)**	**7 Hours**
SQL: Characteristics, Advantages, Data Types, and Literals, SQL Languages: **DDL: Tables:** Create, Delete, Alter, truncate, drop, **DML:** Insert, Delete, Update, Select Query and Clauses (Where, Group By, Having and Order By), Null Values, SQL Operators, Index, and Sequence. **Views:** Create, Drop, Update		
#Exemplar/Case Studies: Implement queries for the database designed in the Unit II		
***Mapping of Course Outcomes**	**CO1,CO3**	
Unit IV	**Transaction Management**	**7 Hours**
Introduction, States, ACID properties, **Schedule**: Concept, Serial and Concurrent, **Serializability:** Conflict and View, **Concurrency Control:** Lock-based, Time-stamp-based, **Deadlock:** Detection, Prevention and recovery.		
#Exemplar/Case Studies: Role of transaction management in financial transaction apps to maintain data consistency, atomicity, and concurrency control (e.g. leading apps: Phonepe, Gpay but not limited to)		
***Mapping of Course Outcomes**	**CO4**	
Unit V	**Parallel Databases**	**7 Hours**
Introduction, Parallel Processing Concepts, Shared-Memory and Shared-Nothing Architectures, Data Partitioning Techniques, Real-World Applications of Parallel Databases: Data Warehousing, Data Mining, Big Data Analytics.		
#Exemplar/Case Studies: Scaling a Global Retail Giant's Database		
***Mapping of Course Outcomes**	**CO5**	
Unit VI	**NoSQL Databases**	**7 Hours**
Types of Data: Structured, Unstructured, and Semi-Structured, **NoSQL Database:** Introduction, Need, Types (Key-value store, Document store, Graph, Column stores), CAP Theorem, BASE Properties, **MongoDB:** CRUD Operations, Indexing, Aggregation		
#Exemplar/Case Studies: Use of NoSQL databases to process unstructured social media data.		
***Mapping of Course Outcomes**	**CO3**	
Learning Resources		
Text Books		
T1. Silberschatz A., Korth H., Sudarshan S., "Database System Concepts", McGraw Hill Publishers, ISBN 0-07-120413-X, 6th edition T2. Acharya Seema "Demystifying NoSQL", New Delhi Wiley India 2020, ISBN: 978-81-265-7996-9, First Edition.		
Reference Books :		
R1. C J Date, "An Introduction to Database Systems", Addison-Wesley, ISBN: 0201144719 R2. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", McGraw Hill International Editions, ISBN:		

978-0072465631, Third Edition.
R3. MAHESHWARI SHARAD, "INTRODUCTION TO SQL AND PL/SQL", Firewall Media; 2009

Additional Resources: (Books, e-Resources)

1. e-Books: 1. SQL and Relational Theory a. (How to Write Accurate SQL code), C.J. Date, O'Reilly Publication
2. SQL A Beginner's Guide, Andy Oppel, Robert Sheldon, McGraw Hill Publication
3. https://www.geeksforgeeks.org/introduction-to-nosql/
4. https://www.mongodb.com/resources/basics/databases/nosql-explained
5. Unit 6 case study: https://www.yugabyte.com/blog/facebooks-user-db-is-it-sql-or-nosql/

MOOC Courses links :

- https://onlinecourses.nptel.ac.in/noc24_cs21/preview
- https://onlinecourses.nptel.ac.in/noc25_cs40/preview

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MDM (A) Syllabus Offered by E&TC Engineering for Other Branch Students for SEM III and SEM IV

24-MDM-ET-2-01A- Internet of Things

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

Prerequisites Courses: 24-ESC-1-01: Basic Electrical & Electronics Engineering, 24-MDM-ET-2-03: Digital Electronics and Microprocessor .

Companion Course: 24-MDM-ET-2-02: Internet of Things Lab

Course Objectives:

- To study fundamental concepts of IoT
- To Learn different communication protocols used for IoT design
- To be familiar with different applications of IoT.

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

CONo	**CO**	**BL**
CO1	**Understand** the various concepts, terminologies, and architecture of IoT systems.	**2**
CO2	**Interface** various sensors, actuators to the development boards and Compare different boards.	**3**
CO3	**Analyze** IoT protocols for making IoT devices communication.	**4**
CO4	**Understand** various applications of IoT.	**2**

Course Contents

Unit I	**Introduction & Basic of IoT**	**8 Hours**

Definition, Characteristics, Physical & logical Designs, IoT enabling Technologies, IoT levels and deployment templates, Major components of IoT systems. IoT Development Boards: Arduino IDE and Board Types, Raspberry Pi Development Kit, Beagle bone, ESP8266, Overview of Raspbian OS.

#Exemplar/Case Studies:A manufacturing company wanted to reduce downtime by predicting machinery failures in advance using IIoT to implement the same.

***Mapping of Course Outcomes**	**CO1,CO4**

Unit II	**Sensors & Actuators**	**7 Hours**

Definition, Types of Sensors (Temperature sensor, Humidity sensor, Displacement sensor, Force, pressure, flow, vibration, acceleration, proximity, optical sensors), Types of Actuators (motors, Pneumatic Actuators etc) their working, RFID Principles and Components.

#Exemplar/Case Studies: Study of sensors at Toll Plaza.		
***Mapping of Course Outcomes**	**CO2,CO4**	
Unit III	**IoT Protocols**	**8 Hours**
Wireless Technologies for IoT: WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus. IP Based Protocols for IoT : IPv6, 6LowPAN, RPL, REST, AMQP, CoAP, MQTT. Edge connectivity and protocol.		
#Exemplar/Case Studies: 7 rings contactless payment wearable.		
***Mapping of Course Outcomes**	**CO3,CO4**	
Unit IV	**Applications of IoT**	**8 Hours**
Home Automation, Smart Cities,Automobile, Retail Management, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.		
#Exemplar/Case Studies: Study of Smart Cities of India (Ahmedabad, Coimbatore)		
***Mapping of Course Outcomes**	**CO4**	

Text Books

T1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, ISBN: 0: 0996025510
T2. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", 2nd Edition,Wiley Publication, ISBN: 978-1-119-99435-0

Reference Books

R1. Simone Cirani, Internet of Things- Architecture, Protocols and standards", Wiley, 2018.
R2. Alessandro Bassi, " Enabling Things to talk-Designing IoT Solutions with the IoT Architectural Reference model", Springer
R3. Charles Crowell, "IoT-Internet of Things for Beginners: An Easy-to-Understand Introduction to IoT",ISBN-13 : 979-8613100194
R4. David Hanes, Gonzalo Salgueiro, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press, ISBN-13: 978-1-58714-456-1 ISBN-10: 1-58714-456-5

Additional Resources: (Books, e-Resources):

1. https://www.iotforall.com/ebooks/an-introduction-to-iot
2. https://www.qorvo.com/design-hub/ebooks/internet-of-things-for-dummies
3. **https://www.viasmartcities.com/smart-city-ahmedabad/**

MOOC Courses links:

1. https://nptel.ac.in/courses/106/105/106105166/
2. https://www.udemy.com/course/a-complete-course-on-an-iot-system-design-anddevelopment/
3. https://www.coursera.org/learn/iot.

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

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

Prerequisites Courses: -

Companion Course:24-MDM-ET-2-01:Internet of Things

Course Objectives:

- To learn various techniques, tools, applications in IoT.
- To learn cloud platforms like Blynk and Thingspeak.

Course Outcomes:

After completion of the course, learners should be able to-

CONo	CO	BL
CO1	**Implement** the interfacing of various sensors with microcontrollers	**3**
CO2	**Interpret and analyze** data on the cloud using IoT boards	**3**
CO3	**Implement** IoT-based solutions to develop smart applications	**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, conclusion/analysis. Program codes with sample output of all performed assignments will be submitted as softcopy. DVD containing student programs maintained by the Laboratory in charge is highly encouraged.

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 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

Suggested List of Laboratory Experiments/Assignments

Group A: Assignments (Mandatory Assignment)

Sr No	Assignment Title	*Mapping of CO
1.	Understand the connection and configuration of GPIO and its use in programming. Write an application of the use of push switches and LEDs.	CO1
2.	Write a program to interface a motion sensor with Ardino. If the motion is detected then it is notified by a buzzer and LED.	CO1
3	Write a program to interface DHT11 and upload sensor data to the cloud.	CO1,CO2
4.	Interface Ultrasonic sensor with raspberry pi to monitor the distance of an object.	CO1,CO2
5	Design a system to interface a stepper motor with a Raspberry Pi for precise motor control. Ensure proper communication, power management, and step sequence execution."	CO1,CO2

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

Sr No	Assignment Title	*Mapping of CO
1.	Sending Data Between Two Arduinos Using I2C Protocol.	CO1,CO2
2	Color Detection and Monitoring Using ESP8266 and ThingSpeak.	CO1,CO2
3	Design and develop a gas detection system using an MQ2 sensor with NodeMCU and Blynk to monitor air quality and send real-time mobile notifications for safety alerts.	CO1,CO2

Group C: Assignments (Any 1)

Sr No	Assignment Title	*Mapping of CO
1.	Design and develop a smart home application that enables users to remotely control appliances such as fans and lights, ensuring convenience, energy efficiency, and automation.	CO1,CO3
2.	Design and develop an automatic touchless water tap system using Arduino or Raspberry Pi, enabling hygienic and efficient water flow control through sensor-based activation.	CO1,CO3

24-MDM-ET-2-03A: Digital Electronics and Microprocessor

Teaching Scheme:	**Credits:** 3	**Examination Scheme:**
Theory: 3 Hours/Week		**CIE** :20 Marks **MSE :**20 Marks **SEE** : 60 Marks

Prerequisite Course :24-ESC-1-01: Basic Electrical & Electronics Engineering.

Companion Course:

Course Objectives:

- To study number systems, Booleans Laws & logical gates used in digital systems.
- To design various combinational and sequential circuits.
- To learn the architecture of advanced processors.
- To study memory management & need of protections for microprocessors.

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

CO No	CO	BL
CO1	**Apply** the knowledge of number systems, logic gates & minimization techniques.	**3**
CO2	**Design** combinational & sequential logic circuits.	**3**
CO3	**Explain** architecture of advanced microprocessors, Interrupts & Exceptions in applications.	**2**
CO4	**Use** memory management in microprocessors.	**2**
CO5	**Identify** need of protections & multitasking for microprocessor 80386.	**2**

Course Contents

Unit I	**Number systems and Logic gates.**	**6 Hours**

Number systems: Binary number systems, Octal number system, decimal & hexadecimal number system & conversions, Binary addition & subtraction, 1"s and 2"s complement.
Logic Gates: Introduction to logic gates, Universal gates, Boolean Laws, DE Morgan's law, Sum of Product (SOP) & Product of Sum (POS) Form, Karnaugh Map.

#Exemplar/Case Studies: Washing Machine Control using basic AND & NOT gates using virtual lab.

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

Unit II	**Combinational Logic Circuits**	**8 Hours**

Adders, Subtractors, Code converters (Binary to Gray, Gray to Binary, BCD to 7 Segment code display), parity generators, magnitude

comparator, multiplexer/ demultiplexer using gates, Multiplexer & Demultiplexer trees.		
#Exemplar/Case Studies: Design & Simulate Various Code Converters/Multiplexers/Demultiplexers using virtual lab.		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Sequential Logic Circuits**	**8 Hours**
Latches & Flip-Flop,Clocked SR,JK,D,T Flip-flop,Conversion of Flip-flop,application of flip flops.Shift register, Mod-n counters, up/down counters, decade counter, Ring Counter.		
#Exemplar/Case Studies: Applications of Sequential Circuits: Elevator Control System		
***Mapping of Course Outcomes**	**CO1,CO2**	
Unit IV	**Introduction to 80386**	**8 Hours**
Evolution of Intel Processors, 80386 DX Features and Architecture, Programmers Model, Operating modes, Addressing modes and data types. **Interrupts and Exceptions**: Identifying Interrupts, Enabling and Disabling Interrupts, Priority among Simultaneous Interrupts and Exceptions, Interrupt Descriptor Table (IDT), IDT Descriptors, Interrupt Tasks and Interrupt Procedures, Error Code, and Exception Conditions.		
#Exemplar/Case Studies: Perform Comparative study on the Intel Core i5, i7 and i9 Architecture		
***Mapping of Course Outcomes**	**CO3**	
Unit V	**Memory Management**	**7 Hours**
Global Descriptor Table, Local Descriptor Table, Interrupt Descriptor Table, GDTR, LDTR, IDTR. Formats of Descriptors and Selector, Segment Translation, Page Translation, Combining Segment and Page Translation.		
#Exemplar**/Case Studies**: Memory Management in a Simple Operating System (OS-Lite)		
***Mapping of Course Outcomes**	**CO3,CO4**	
Unit VI	**Multitasking and Protection**	**7 Hours**
Multitasking- Task State Segment, TSS Descriptor, Task Register, Task Gate Descriptor, Task Switching, Task Linking, Task Address Space. Need of Protection, Overview of 80386DX Protection Mechanisms: Protection rings and levels,Privileged Instructions, Concept of DPL, CPL, RPL, EPL.		
#Exemplar/Case Studies**:** How an i5 Processor Handles Multitasking		
***Mapping of Course Outcomes**	**CO3,CO4,CO5**	
Learning Resources		
Text Books		

T1. M Morris Mano, Digital Design, 5th Edition, 2013, Pearson Education, ISBN-10: 0-13- 277420-8 / ISBN-13: 978-0-13-277420-8.
T2. R.P. Jain, "Modern Digital Electronics" 4 th Edition, 2009, Tata McGraw-Hill, ISBN 10: 0070669112 / ISBN 13: 9780070669116.
T3. Douglas Hall, SSS P Rao, "Microprocessors and its Interfacing (SIE)", 3rd Edition, 2017, McGraw Hill, ISBN-10: 9781259006159

Reference Books

R1. Anil Maini, Digital Electronics: "Principles and Integrated Circuits", Wiley India Ltd, ISBN:978-81-265-1466-3.
R2. Chris H. Pappas, William H. Murray, "80386 Microprocessor Handbooks", McGraw-Hill Osborne Media, ISBN-10: 0078812429, 13: 978-0078812422.

Additional Resources: (Books, e-Resources)

- https://www.springer.com/gp/book/9783030361952
- https://www.mheducation.co.uk/ebook-fundamentals-of-digital-logic-9780077144227-emea

MOOC Courses links :

- Digital Circuits, by Prof. Santanu Chattopadhyay, https://swayam.gov.in/nd1_noc19_ee51/preview
- Digital Circuits and Systems, Prof. S. Srinivasan https://nptel.ac.in/courses/117/106/117106086/
- Switching Circuits And Logic Design By Prof. Indranil Sengupta: https://swayam.gov.in/nd1_noc20_cs67/preview
- Digital Application Virtual Lab Link:https://da-iitb.vlabs.ac.in/List%20of%20experiments.html
- https://nptel.ac.in/courses/106/108/106108100/
- https://nptel.ac.in/courses/108/107/108107029/

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 for Second Year B. Tech. in Electronics & Telecommunication Engineering with Multidisciplinary Minor
To be implemented for 2024-28 Batch
(With Effect from Academic Year 2025-26)

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

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

Teaching Scheme:	**Credit:** 3	**Examination Scheme:**
Theory: 3 Hours/Week		**CIE**: 20 Marks **MSE:** 20 Marks **SEE**: 60 Marks

Prerequisites Courses:-

Companion Course: -

Course Objectives:

- To understand the fundamental principles and evolution of Lean Systems.
- To identify and analyze the types of waste (Muda) in operational processes.
- To apply basic Lean tools and techniques to improve process efficiency in simple scenarios.
- To explain strategies for implementing and sustaining Lean practices in organizations.
- To calculate Lean performance metrics and understand their significance in continuous improvement.

Course Outcomes:

After completion of the course, learners should be able to

CONo	**CO**	**BL**
CO1	**Explain** the principles and evolution of Lean Systems.	**2**
CO2	**Identify** the eight types of waste (Muda) and describe methods to reduce them.	**2**
CO3	**Apply** Lean tools such as 5S, Kaizen, and Kanban to improve process efficiency.	**3**
CO4	**Describe** strategies to implement and sustain Lean practices in an organization.	**2**
CO5	**Calculate** cycle time and Overall Equipment Effectiveness (OEE) using basic process data.	**3**
CO6	**Understand** the importance of leadership and employee involvement in fostering a Lean culture.	**2**

Course Contents

Unit I	**Introduction to Lean Systems**	**7 Hours**

Overview of Lean Systems: Definition and Purpose, Core Lean Principles: Value, Value Stream, Flow, Pull, Perfection, History of Lean: From Toyota Production System (TPS) to Modern Applications, Lean Thinking: Mindset for Efficiency and Waste Reduction, Benefits of Lean: Cost Savings, Quality Improvement, Speed, Challenges of Lean: Resistance, Training, Sustaining Change.

#Exemplar/Case Studies: Toyota Production System (TPS) (How Toyota revolutionized the automobile industry using Lean principles to minimize waste, optimize production, and improve efficiency.)

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

Unit II	**Waste Identification and Reduction**	**7 Hours**
Definition of Waste (Muda) in Lean Systems, Types of Waste: Defects, Overproduction, Waiting, Unused Talent, Transport, Inventory, Motion, Extra processing (DOWNTIME) Methods to Identify Waste in Processes, Techniques for Waste Reduction: process Analysis, Standardization, Pull Systems, Benefits of Waste Reduction: Efficiency and Cost Savings		
#Exemplar/Case Studies: Harley-Davidson's Lean Turnaround (How Harley-Davidson identified and reduced waste like excess inventory and overproduction in its manufacturing processes, improving efficiency and profitability.)		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Lean Tools and Techniques**	**7 Hours**
Introduction to Lean Tools, 5S, Kaizen: Continuous Improvement Principles and Practices, Kanban: Visual Scheduling and Pull System Basics, Value Stream Mapping (VSM): Mapping Processes to Identify Waste, Benefits of Lean Tools: Improved Workflow and Productivity		
#Exemplar/Case Studies: Toyota's Assembly Line (How Toyota implemented Kanban and 5S to optimize its assembly line, reducing waste and ensuring smooth flow in car production.)		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Lean Implementation Strategies**	**7 Hours**
Overview of Lean Implementation: Steps and Planning, Engaging Stakeholders: Leadership and Team Involvement, Overcoming Challenges: Resistance, Resource Constraints, Training Needs, Sustaining Lean Practices: Standardization, Audits, Continuous Feedback, Tools for Implementation: Pilot Projects, Gemba Walks, Benefits of Effective Strategies: Long-term Efficiency Gains		
#Exemplar/Case Studies: Boeing's Lean Journey (How Boeing implemented Lean strategies in aircraft manufacturing, overcoming resistance and sustaining gains through training and standardization.)		
***Mapping of Course Outcomes**	**CO4**	
Unit V	**Lean Metrics and Performance Measurement**	**7 Hours**
Introduction to Lean Metrics: Purpose and Importance, Key Performance Indicators (KPIs): Cycle Time, Throughput, Lead Time, Overall Equipment Effectiveness (OEE): Availability, Performance, Quality Components, Calculating Metrics: Basic Formulas and Examples, Using Metrics to Assess Efficiency and Identify Waste, Benefits of Performance Measurement: Data-Driven Improvement		
#Exemplar/Case Studies: General Motors (GM) Lean Metrics (How GM used OEE and cycle time metrics to measure and improve assembly line efficiency, reducing downtime and boosting productivity.)		
***Mapping of Course Outcomes**	**CO5**	
Unit VI	**Lean Culture and Employee Involvement**	**7 Hours**
Definition of Lean Culture: Values and Behaviors, Role of Leadership: Vision, Support, Accountability, Employee Engagement:		

Participation, Empowerment, Training, Building a Lean Culture: Communication, Teamwork, Recognition, Sustaining Culture: Kaizen Events, Feedback Loops, Benefits of Employee Involvement: Motivation, Continuous Improvement	
#Exemplar/Case Studies: Toyota's People-First Culture (How Toyota built a Lean culture through leadership commitment and employee empowerment, fostering continuous improvement via Kaizen.)	
***Mapping of Course Outcomes**	**CO6**
Learning Resources	
Text Books	
T1. Bill Carreira, *Lean Manufacturing That Works: Powerful Tools for Dramatically Reducing Waste and Maximizing Profits*, Prentice-Hall of India Private Limited, 2007. **T2.** Ronald G. Askin, *Design and Analysis of Lean Production Systems*, John Wiley and Sons, 2007.	
Reference Books :	
R1. John M. Nicholas, Competitive Manufacturing Management: Continuous Improvement, Lean Production, Customer-Focused Quality, Tata McGraw Hill Education Private Limited, 2011. **R2.** Debashis Sarkar, Lean for Service Organizations and Offices: A Holistic Approach for Achieving Operational Excellence and Improvements, Pearson Education India, 2009.	
Additional Resources: (Books, e-Resources) ● Lean Enterprise Institute (LEI) - What is Lean?, https://www.lean.org/explore-lean/what-is-lean/ ● ASQ (American Society for Quality) - Lean Overview, https://asq.org/quality-resources/lean	
MOOC Courses links : ● Foundations of Lean Manufacturing, https://onlinecourses.swayam2.ac.in/imb25_mg49/preview	

24-MDM-ET-2-02B: Industry 4.0 Concepts and Technologies

Teaching Scheme:	**Credit:** 3	**Examination Scheme:**
Theory: 3 Hours/Week		**CIE**: 20 Marks **MSE**: 20 Marks **SEE**: 60 Marks

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

Companion Course:

Course Objectives:

- To understand the evolution and significance of Industry 4.0 in modern manufacturing.
- To identify the core elements and technologies driving Industry 4.0.
- To explain the role and architecture of Cyber-Physical Systems (CPS) in industrial applications.
- To apply Internet of Things (IoT) concepts to enhance connectivity and efficiency in industrial processes.
- To describe automation technologies and their integration in Industry 4.0 environments.

Course Outcomes:

After completion of the course, learners should be able to

CONo	**CO**	**BL**
CO1	Explain the progression and key drivers of Industry 4.0 and their impact on modern manufacturing.	**2**
CO2	Identify the primary components and technologies of Industry 4.0.	**2**
CO3	Describe the structure and applications of Cyber-Physical Systems (CPS).	**2**
CO4	Apply IoT principles to analyze connectivity for efficiency improvements.	**3**
CO5	Demonstrate the use of automation tools and techniques through case studies.	**3**
CO6	Understand the integration of digital transformation technologies and their role in enhancing productivity.	**2**

Course Contents

Unit I	**Fundamentals of Industry 4.0**	**7 Hours**

Definition and Scope of Industry 4.0, Evolution: Industry 1.0 to 4.0 with Key Milestones, Key Drivers: Digitalization, Connectivity, Automation, Data Analytics, Benefits: Efficiency, Flexibility, Customization, Reduced Time-to-Market, Challenges: Cost, Skills Gap, Security, Global Adoption Trends

#Exemplar/Case Studies: Siemens' Digital Factory (How Siemens transitioned to Industry 4.0, integrating digital tools for efficiency in its Amberg plant.)

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

Unit II	**Elements of Industry 4.0**	**7 Hours**
Core Components of Industry 4.0: IoT, CPS, Big Data, Cloud Computing, AI, Technologies: Robotics, Additive Manufacturing (3D Printing), Augmented Reality, Interconnectivity and Data Exchange Standards (e.g., OPC UA), Role in Smart Manufacturing: real-Time Decision-Making, Challenges of Integration: Interoperability, Scalability		
#Exemplar/Case Studies: Bosch's Industry 4.0 Deployment (How Bosch used IoT and Big Data across its factories for real-time production insights.)		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Cyber-Physical Systems (CPS)**	**7 Hours**
Definition and Concept of CPS, Architecture: Sensors, Actuators, Control Systems, Embedded Systems, Role in Industry 4.0: Real-Time Monitoring, Decision-Making, Self-Optimization, Applications: Smart Grids, Manufacturing, Autonomous Vehicles, Benefits: Precision, Adaptability, Reduced Downtime		
#Exemplar/Case Studies: Tesla's Gigafactory (How Tesla leverages CPS for real-time production control in electric vehicle manufacturing.)		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Internet of Things (IoT) in Industry 4.0**	**7 Hours**
Basics of IoT: Devices, Networks, Data Flow, Protocols (e.g., MQTT), Industrial IoT (IIoT): Connectivity and Sensors in Manufacturing, Applications: Predictive Maintenance, Asset Tracking, Supply Chain Optimization, Benefits: Real-Time Insights, Efficiency, Reduced Costs, Challenges: Security, Scalability, Data Overload		
#Exemplar/Case Studies: GE's Brilliant Factory (How GE uses IIoT to monitor equipment and reduce downtime in its plants.)		
***Mapping of Course Outcomes**	**CO4**	
Unit V	**Automation in Industry 4.0**	**7 Hours**
Overview of Automation: Robotics, AI, Programmable Logic Controllers (PLCs), Types: Fixed, Programmable, Flexible Automation, Integration with Industry 4.0: Smart Robots, Collaborative Robots (Cobots), Machine Learning, Benefits: Speed, Accuracy, Reduced Labor Costs, Safety, Challenges: Upfront Costs, Maintenance, Workforce Transition		
#Exemplar/Case Studies: Fanuc's Automated Plants (How Fanuc employs robotics and automation for precision manufacturing in Japan.)		
***Mapping of Course Outcomes**	**CO5**	
Unit VI	**Industry 4.0: Digital and Technological Integration**	**7 Hours**
Digital Transformation: Concepts, Strategies, Roadmap, Smart Factories: Features, Real-Time Control, Self-Organizing Systems, Advanced Technologies: AI, Machine Learning, Digital Twins, Blockchain, Benefits: Agility, Innovation, Sustainability, Challenges: Complexity, Investment, Data Governance		

#Exemplar/Case Studies: Reliance Jio's Smart Manufacturing (How Jio integrates digital twins and AI in its Indian facilities for optimized production.)	
***Mapping of Course Outcomes**	**CO6**
Learning Resources	
Text Books	
T1. U. K. Singh and J. M. Dewan, Industry 4.0: Concepts, Technologies, and Applications, PHI Learning Pvt. Ltd., 2021. **T2**. Alpana Upadhyay and S. K. Jain, Smart Manufacturing: Concepts and Applications, Tata McGraw Hill Education, 2020.	
Reference Books :	
R1. Debashis Sarkar, Lean for Service Organizations and Offices: A Holistic Approach for Achieving Operational Excellence and Improvements, Pearson Education India, 2009. **R2.** P. N. Rao, Manufacturing Technology: Industry 4.0 Perspective, Tata McGraw Hill Education, 2018.	
Additional Resources: (Books, e-Resources) ● Industry 4.0 and its impact on Manufacturing Sector, https://www.coursera.org/learn/industry-4-point-0-and-its-impact-on-manufacturing-sector	
MOOC Courses links ● Introduction To Industry 4.0 And Industrial Internet Of Things, https://onlinecourses.nptel.ac.in/noc25_cs43/preview ● Introduction To Internet Of Things, https://onlinecourses.nptel.ac.in/noc25_cs44/preview	

MDM Syllabus Offered by Mechanical Engineering for Other Branch Students for SEM III and SEM IV

24-MDM-ME-2-01 : Engineering Materials and Safety		
Teaching Scheme: Theory: 2 Hours/Week	**Credit:** 2	**Examination Scheme:** **CIE** : 20 Marks **MSE : -** **SEE** : 30 Marks

Prerequisite Course: 24-ESC-1-04 : Smart Building and Materials

Companion Course: 24-MDM-ME-2-02 : Engineering Materials and Safety Lab

Course Objectives:

- To provide an understanding of construction materials' properties, selection, and applications.
- To introduce quality control techniques in construction processes.
- To impart knowledge on workplace safety standards and practices in construction projects.
- To enhance skills in managing safety, quality, and material procurement effectively.

Course Outcomes:

After completion of the course, learners should be able to

CO No	CO	BL
1	**Select** appropriate materials based on their properties and applications.	2
2	**Apply** quality control and assurance techniques in construction projects.	3
3	**Understand** safety protocols, hazard identification, and risk management.	2
4	**Prepare** safety manuals, inspection reports, and checklists for construction sites.	2

Course Contents

Unit I	**Introduction to Materials**	**8 Hours**

Properties and classification of materials: Cement, aggregates, concrete, steel, timber, glass, and plastics. Criteria for material selection: Cost, availability, durability, and sustainability. Testing of materials: Compression, tensile and impact, Sustainable Materials: Types, advantages and disadvantages.

#Exemplar/Case Studies: Advanced Materials**:** Nano-materials-GGBS, Fly ash

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

Unit II	**Quality Management**	**8 Hours**

Quality: Various definitions and interpretation, factors affecting quality, Evolution of TQM: QC, TQC, QA, QMS, TQM, PDCA cycle, Six sigma: Importance and levels, defects & its classification, importance of checklists in achieving quality.

#Exemplar/Case Studies: Typical checklist for concreting activity, formwork activity.		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Safety in Projects**	**7 Hours**
Introduction to safety management, Common hazards and risks on construction sites, Safety regulations, standards, Roles and responsibilities: Management, site managers, supervisors, safety officers, and workers.		
#Exemplar/Case Studies: Marina Bay Sands Construction Project		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Monitoring and Improving Safety and Quality**	**7 Hours**
Monitoring systems for safety and quality performance, Incident investigation and reporting: Root causes analysis, 5 Why analysis, Role of safety committees and audits in improving safety performance, Continuous improvement: Feedback systems and benchmarking practices.		
#Exemplar/Case Studies	Bangladesh Rana Plaza Collapse (2013)	
***Mapping of Course Outcomes**	**CO3,CO4**	
Learning Resources		
Text Books		
T1. Quality Control and Total Quality Management P. L. Jain- Tata McGraw Hill Publ. Company **T2.** Building Materials by S.K. Duggal **T3.** Construction Safety Management by Raymond E. Levitt and Nancy M. Samelson		
Reference Books :		
R1. Materials for Civil and Construction *Engineers* by Michael S. Mamlouk and John P. Zaniewski **R2.** Relevant BIS standards (ISO 9001 for Quality Management System, IS/ISO:450001 for Safety Management System, IS 456:2000 for concrete structures)		
Additional Resources: (Books, e-Resources)		
MOOC Courses links : ● https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-ce16/ ● https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-ce10/		

24-MDM-ME-2-02: Engineering Materials and Safety Lab		
Teaching Scheme: Practical: 2 Hours/Week	**Credit:** 1	**Examination Scheme:** **Term work (TW)** : 25 Marks **Oral (OR)** : 25 Marks

Prerequisite Course: 24-ESC-1-09: Smart Building and Materials Lab

Companion Course: 24-MDM-ME-2-01 : Engineering Materials and Safety

Course Objectives:

- To familiarize students with different types of engineering materials and their properties.
- To understand the safety aspects while handling materials and performing lab work.
- To enhance awareness of industrial safety norms and personal protective equipment (PPE).
- To introduce students to the importance of material selection for engineering applications.

Course Outcomes:

After completion of the course, learners should be able to

Co No	CO	BL
1	**Demonstrate** properties of the engineering materials	3
2	**Assimilate** safety protocols and emergency procedures	2
3	**Understand** quality and safety management systems	2
4	**Investigate** industry safety practices	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, 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.

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 and punctuality.

Guidelines for Practical / Oral Examination

Problem statements must be decided jointly by the internal examiner and external examiner. During the practical/oral 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

- Understand the objectives of the experiment.
- Wear appropriate PPE (lab coat, goggles, gloves, etc.).
- Keep your workspace organized and tidy.
- Record observations and data meticulously.
- Report any damaged or malfunctioning equipment immediately.
- Report accidents, spills, or injuries immediately.
- Analyze and review experiment results accurately.
- Follow institutional and regulatory guidelines.

Suggested List of Laboratory Experiments/Assignments

Group A: Assignments (Mandatory Assignment)

Sr. No.	Assignment Title	*Mapping of Course Outcomes
1.	Determine the particle size distribution of fine and coarse aggregates	CO1
2.	Identify and demonstrate the use of PPE for specific industrial activities.	CO2
3.	Develop quality checklists and inspection reports for a commercial project.	CO3
4.	Create checklists for scaffolding, excavation, and material handling activities.	CO3
5.	Prepare a comprehensive safety management plan for a mini project.	CO3
6.	Conduct an audit of materials (cement, aggregates, steel, etc.) stored in college campus.	CO1

Group B: Assignments

Sr. No.	Assignment Title	*Mapping of Course Outcomes
1.	Demonstrate fire safety protocols, use of fire extinguishers, and evacuation plans.	CO2

	OR	
2.	Demonstrate the abrasion of tile using tile abrasion testing machine.	CO1
3.	Demonstrate a fire mock drill of College Campus	CO2
	OR	
4.	Simulate a construction accident and prepare an investigation report highlighting the root cause and preventive measures.	CO2
Group C: Assignment		
Sr. No.	**Assignment Title**	***Mapping of Course Outcomes**
1.	Conduct a field visit to an industry to observe and understand safety procedures and protocols.	CO4
Learning Resources (If applicable)		
Text Books		
T1. Quality Control and Total Quality Management P. L. Jain- Tata McGraw Hill Publ. Company **T2.** Building Materials by S.K. Duggal **T3.** Construction Safety Management by Raymond E. Levitt and Nancy M. Samelson		
Reference Books :		
R1. Materials for Civil and Construction *Engineers* by Michael S. Mamlouk and John P. Zaniewski **R2.** Relevant BIS standards **R3**. Industrial Safety and Health Management – C. Ray Asfahl & David W. Rieske		
Additional Resources: (Books, e-Resources)		
MOOC Courses links : ● https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-ce16/ ● https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-ce10/		

24-MDM-ME-2-03: Sustainable Energy Technology

Teaching Scheme: Theory: 3 Hours/Week	**Credit:** 3	**Examination Scheme:** **CIE** : 20 Marks **MSE :** 20 Marks **SEE** : 60 Marks

Prerequisite Course: -

Companion Course: -

Course Objectives:

- Understand the transition from fossil fuels to renewable energy driven by sustainability challenges.
- Explore key sustainable energy technologies like solar, wind, hydro, and biomass.
- Examine methods to improve energy efficiency and sustainability.
- Study advancements in energy storage and grid flexibility.
- Analyze India's energy challenges and opportunities.

Course Outcomes:

After completion of the course, learners should be able to

CO No	CO	BL
1.	**Understand** the fundamentals of sustainable energy and the transition from fossil fuels to renewable sources.	2
2.	**Explain** the working principles and applications of solar, wind, hydro, biomass, and geothermal energy technologies.	2
3.	**Explore** energy storage systems, smart grids, and emerging solutions for efficient energy management.	3
4.	**Understand** the role of nuclear energy and other innovative technologies in the future energy landscape.	2
5.	**Examine** India's energy challenges, policies, and opportunities in the shift toward sustainability.	2
6.	**Apply** knowledge of sustainable energy technologies to address real-world energy problems and innovations.	3

Course Contents

Unit I	**Sustainable Energy**	**7 Hours**

Introduction, energy scenario in the modern world, fossil fuels, climate change impacts and overview of renewable energy technology, global energy demand, and environmental impact, the transition from fossil fuels to renewable energy, overview of carbon-neutral energy sources, energy policies, and sustainability goals.

#Exemplar/Case Studies: Germany's Energy Transition

***Mapping of Course Outcomes**	**CO1**	
Unit II	**Solar and Wind Energy Technologies**	**7 Hours**
Solar photovoltaics (PV) and solar thermal systems, wind energy principles, types of wind turbines, grid integration and storage solutions for solar and wind, challenges and advancements in large-scale deployment.		
#Exemplar/Case Studies: Bhadla Solar Park, India.		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Hydropower, Biomass, and Geothermal Energy**	**7 Hours**
Hydroelectric power: types, working principles, and sustainability concerns, Biomass energy: conversion technologies and biofuels, Geothermal energy: resources, extraction, and applications, environmental and economic aspects of these technologies.		
#Exemplar/Case Studies: Bhakra Nangal Dam, India.		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Energy Storage and Smart Grid Systems**	**7 Hours**
Battery technologies and energy storage solutions, hydrogen as an energy carrier and fuel cells, smart grids and demand-side management, role of AI and IoT in energy optimization.		
#Exemplar/Case Studies: Hornsdale Power Reserve, Australia.		
***Mapping of Course Outcomes**	**CO4**	
Unit V	**Nuclear Energy and Emerging Technologies**	**7 Hours**
Basics of nuclear fission and fusion technologies, advanced nuclear reactors and small modular reactors (SMRs), tidal and ocean energy systems, future trends in sustainable energy research.		
#Exemplar/Case Studies: Fukushima Daiichi Nuclear Disaster (2011 Japan Tsunami).		
***Mapping of Course Outcomes**	**CO5**	
Unit VI	**India's Energy Transition: Challenges & Opportunities**	**7 Hours**
India's energy scenario: demand, supply, and policies, renewable energy targets and government initiatives, challenges in grid integration and energy access, the role of startups, innovation, and investments in India's energy sector.		
#Exemplar/Case Studies: India's Renewable Energy Targets and Achievements (National Solar Mission)		
***Mapping of Course Outcomes**	**CO6**	
Learning Resources		
Text Books		
T1. Renewable Energy Technologies: A Practical Guide for Beginners by Chetan Singh Solanki, PHI. **T2.** Fundamentals of Renewable Energy Systems by D. Mukherjee & S. Chakrabarti New Age International publishers.		

Reference Books :

R1. Renewable Energy Sources and Emerging Technologies by D.P. Kothari, K.C. Singal, Rakesh Ranjan, PHI publishers.
R2. Non-Conventional Energy Sources by G.D. Rai, Khanna Publishers.

Additional Resources: (Books, e-Resources)

India's Energy Transition: Mapping Policy and Politics Navroz K. Dubash. Oxford University Press publishers.

MOOC Courses links :

- https://onlinecourses.nptel.ac.in/noc23_me138/preview