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RAJARSHI SHAHU COLLEGE OF ENGINEERING
TATHAWADE, PUNE-33
(An Autonomous Institute Affiliated to SavitribaiPhule Pune University, Pune)

Multidisciplinary Minor
Structure and Syllabus
(2023 Pattern)
W. E. F. 2024-25

NOTE: Student should choose any one specialization given by the department and complete all the courses (14 credits) under the specialization to earn 170 Credits.

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Multidisciplinary Courses List (Credits: 14 Credits) [2023 Pattern]

				Teaching scheme					Marks		Eligible Departments							
Course	**Sem**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Hr**	**C**		**Offered by Dept**	**Comp**	**IT**	**CSBS**	**E&Tc**	**Mech**	**Civil**	**Elect**	**A&R**
COMPUTER ENGINEERING																		
MDM I	IV	CSM2201T	Introduction to Object Oriented Programming	3	-	-	3	3	100									
MDM II	V	CSM3201T	Data Structures	3	-	-	3	3	100									
MDM II	V	CSM3201L	Data Structures Laboratory	-	-	2	2	1	50									
MDM III	VI	CSM3202T	Database Management Systems	3	-	-	3	3	100	**Computer**								
MDM IV	VII	CSM4201T	Computer Network	3	-	-	3	3	100	**For Syllabus**								
MDM IV	VII	CSM4201L	Computer Network Laboratory	-	-	2	2	1	50	**click here**	N	N	N	Y	Y	Y	Y	Y
E &Tc																		
MDM I	IV	ECM2201T	Digital Design & Computer Organization	3	-	-	3	3	100									
MDM II	V	ECM3201T	Microcontroller	3	-	-	3	3	100									
MDM II	V	ECM3201L	Microcontroller Laboratory	-	-	2	2	1	50									
MDM III	VI	ECM3202T	Internet of Things	3	-	-	3	3	100	**E&Tc**								
MDM IV	VII	ECM4201T	Embedded Systems	3	-	-	3	3	100	**For Syllabus**								
MDM IV	VII	ECM4201L	Embedded Systems Laboratory	-	-	2	2	1	50	**click here**	Y	Y	Y	N	Y	Y	Y	Y

Course	Sem	Course Code	Course Title	L	T	P	Hr	C	Marks	Offered by Dept	Comp	IT	CSBS	E&Tc	Mech	Civil	Elect	A&R
Civil																		
MDM I	IV	CEM2201T	Basic Civil Engineering	3	-	-	3	3	100									
MDM II	V	CEM3201T	Building Materials and Construction	3	-	-	3	3	100									
MDM II	V	CEM3201L	Building Materials and Construction Laboratory	-	-	2	2	1	50									
MDM III	VI	CEM3202T	Automation in Civil Engg.	3	-	-	3	3	100									
MDM IV	VII	CEM4201T	Construction Management	3	-	-	3	3	100	**Civil**								
MDM IV	VII	CEM4201L	Construction Management Laboratory	-	-	2	2	1	50	**For Syllabus click here**	Y	Y	Y	Y	Y	N	Y	Y
Mechanical																		
MDM I	IV	MEM2201T	Material Science & Engineering	3	-	-	3	3	100									
MDM II	V	MEM3201T	Manufacturing Technology	3	-	-	3	3	100									
MDM II	V	MEM3201L	Manufacturing Technology Laboratory	-	-	2	2	1	50									
MDM III	VI	MEM3202T	CAD/CAM	3	-	-	3	3	100									
MDM IV	VII	MEM4201T	Automobile Engineering	3	-	-	3	3	100	**Mechanical**								
MDM IV	VII	MEM4201L	Automobile Engineering Laboratory	-	-	2	2	1	50	**For Syllabus click here**	Y	Y	Y	Y	N	Y	Y	Y
Electrical																		
MDM I	IV	EEM2201T	Electrical Technology	3	-	-	3	3	100									
MDM II	V	EEM3201T	Control System	3	-	-	3	3	100									
MDM II	V	EEM3201L	Control System Laboratory	-	-	2	2	1	50									
MDM III	VI	EEM3202T	Electrical Power Systems	3	-	-	3	3	100									
MDM IV	VII	EEM4201T	Energy audit and Demand Management	3	-	-	3	3	100	**Electrical**								
MDM IV	VII	EEM4201L	Energy audit and Demand Management Laboratory	-	-	2	2	1	50	**For Syllabus click here**	Y	Y	Y	Y	Y	Y	N	Y

Course	Sem	Course Code	Course Title	L	T	P	Hr	C	Marks	Offered by Dept	Comp	IT	CSBS	E&Tc	Mech	Civil	Elect	A&R
InformationTechnology																		
MDM I	IV	ITM2201T	Data Structures Essentials	3	-	-	3	3	100									
MDM II	V	ITM3201T	Fundamentals of Operating Systems	3	-	-	3	3	100									
MDM II	V	ITM3201L	Fundamentals of Operating Systems Laboratory	-	-	2	2	1	50									
MDM III	VI	ITM3202T	Computer Network	3	-	-	3	3	100									
MDM IV	VII	ITM4201T	Digital Forensic and Cyber Laws	3	-	-	3	3	100	**IT For Syllabus click here**								
MDM IV	VII	ITM4201L	Digital Forensic and Cyber Laws laboratory	-	-	2	2	1	50		N	N	N	Y	Y	Y	Y	Y
CSBS																		
MDM I	IV	CBM2201T	Business Information System	3	-	-	3	3	100									
MDM II	V	CBM3201T	Data Analytics for Business	3	-	-	3	3	100									
MDM II	V	CBM3201L	Data Analytics for Business Laboratory	-	-	2	2	1	50									
MDM III	VI	CBM3202T	Marketing Management and Marketing Reserach	3	-	-	3	3	100									
MDM IV	VII	CBM4201T	IT Project Management	3	-	-	3	3	100	**CSBS For Syllabus click here**								
MDM IV	VII	CBM4201L	IT Project Management Laboratory	-	-	2	2	1	50		N	N	N	Y	Y	Y	Y	Y

Course	Sem	Course Code	Course Title	L	T	P	Hr	C	Marks	Offered by Dept	Comp	IT	CSBS	E&Tc	Mech	Civil	Elect	A&R
Automation & Robotics																		
MDM I	IV	ARM2201T	Industrial Sensors and its applications	3	-	-	3	3	100									
MDM II	V	ARM3201T	Robotics and its applications	3	-	-	3	3	100									
MDM II	V	ARM3201L	Robotics and its applications Laboratory	-	-	2	2	1	50									
MDM III	VI	ARM3202T	Automation	3	-	-	3	3	100									
MDM IV	VII	ARM4201T	SCADA	3	-	-	3	3	100	**A&R**								
MDM IV	VII	ARM4201L	Fundamentals of PLC and SCADA Laboratory	-	-	2	2	1	50	**For Syllabus click here**	Y	Y	Y	Y	Y	Y	Y	N

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Department of Computer Engineering
Multidisciplinary Minor (offered to other Departments)
Structure (Effective from 2024-25)

Course Code	Course	Teaching Scheme				Credit	Examination Scheme			Total Marks
		L	T	P	Hr	C	ISE	MSE	ESE	
S. Y. Sem IV										
CSM2201T	Introduction to Object Oriented Programming	3	-	-	3	3	20	30	50	100
T. Y. Sem V										
CSM3201T	Data Structures	3	-	-	3	3	20	30	50	100
CSM3201L	Data Structures Laboratory	-	-	2	2	1	ISCE: 30		20	50
T. Y. Sem VI										
CSM3202T	Database Management Systems	3	-	-	3	3	20	30	50	100
B.Tech. Sem VII										
CSM4201T	Computer Network	3	-	-	3	3	20	30	50	100
CSM4201L	Computer Network Laboratory	-	-	2	2	1	ISCE: 30		20	50
Total		**12**	**-**	**4**	**16**	**14**				**500**

Abbreviations:

L – Lecture, **T** – Tutorial, **P** – Practical, **Hr** – Hours, **C** – Credits, **TuT** – Tutorial, **TW**- Term work, **ISE** – In Semester Evaluation, **MSE** – Mid Semester Evaluation, **ESE** – End Semester Evaluation

Notes:

For Theory courses: There shall be MSE, ISE and ESE. The ESE is a separate head of passing.
For Lab courses: There shall be continuous assessment (ISCE consists of ISE and MSE). The ESE is a separate head of passing.

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S. Y. Sem IV

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S. Y. B. Tech (Multidisciplinary Minor I)
Academic Year – 2024-2025 Semester -IV
[CSM2201T]: Introduction to Object Oriented Programming

Teaching Scheme: **TH: - 3 Hours/Week**	**Credit** **3**	**Examination Scheme:** In Sem. Evaluation:20 Marks Mid Sem. Exam: 30 Marks End Sem. Exam: 50 Marks

Course Prerequisites: Fundamentals of Computer Programming

Course Objective:

- To learn the basics of Object-Oriented Concepts and Design.
- To get accustomed to Object oriented programming.

Course Outcome:

After successful completion of the course, students will able to:

CO1: Explain the features of object-oriented programming.
CO2: Design and develop object-oriented program using classes & objects.
CO3: Implement the constructors, destructors and inheritance.
CO4: Apply exception handling and generic programming.
CO5: Implement Files and Streams handling Program.
CO6: Apply standard template library for faster development.

Course Contents

UNIT-I	**Introduction to Object Oriented Programming**	**6 Hours**

Basic concepts of OOP, Benefits of OOP, Introduction to object-oriented design and development, Design steps, Design example, Object oriented languages, Comparison of structured and object-oriented programming languages. Arrays, Pointers and Functions: Arrays, Storage of arrays in memory, Initializing Arrays, Multi-Dimensional Arrays, Pointers, accessing array elements through pointers, passing pointers as function arguments, Functions, Arguments, Inline functions, Function Overloading Polymorphism, Operator Overloading Polymorphism.

UNIT-II	**Classes and Objects:**	**7 Hours**

Data types, operators, expressions, control structures, arrays, strings, Classes and objects, access specifiers, constructors, destructors, operator overloading, type conversion. Storage classes: Fixed vs Automatic declaration, Scope, Global variables, register specifier, Dynamic memory allocation.

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UNIT-III	Constructor, Destructor & Inheritance	7 Hours
Introduction to Constructors, Default Constructors, Parameterized Constructors, Copy Constructors, Multiple Constructors in a Class, Destructors. Inheritance: Introduction to inheritance, Defining Derived Classes, Single Inheritance, Multiple Inheritance, Multi-level Inheritance, Hierarchical Inheritance, Hybrid Inheritance. **Case Studies: Vehicle Rental System, Hospital Management System**		
UNIT-IV	**Templates and Exception handling**	**7 Hours**
Introduction to Templates, Class Templates, Class Templates with Multiple Parameters, Function Templates, Function Templates with Multiple Parameters. Exception handling: Basics of Exception Handling, Types of exceptions, Exception Handing Mechanism, Throwing and Catching Mechanism, Rethrowing an Exception, Specifying Exceptions. **Case Study: Generic Inventory Management System**		
UNIT-V	**Streams and Files:**	**6 Hours**
Opening and closing a file, File pointers and their manipulations, Sequential Input and output operations, multi-file programs, Random Access, command line argument, string class, Date class, Array class, List class, Queue class, User defined class, Generic Class. **Case Study: Student Records System**		
UNIT-VI	**Standard Template Library:**	**6 Hours**
Standard Template Library, Overview of Standard Template Library, Containers, Algorithms, Iterators, Other STL Elements, Container Classes, General Theory of Operation, Vectors. **Case Study: Task Scheduling System**		
Text Books: **T1.** Object Oriented Programming with C++ by Balagurusamy **T2.** C++, the Complete Reference, 4th Edition, Herbert Schildt, TMH. **T3.** Bjarne, Stroutstrup,"The C++ programming Language", Addison Wesley 2013.		
Reference Books: **R1.** Lafore, Robert, "Object Oriented Programming in Turbo C++", Galgotia Publications. **R2.** Booch, "Object Oriented Analysis and Design with Applications", Addison Wesley.		
Online/Web/Other References: **1.** https://www.geeksforgeeks.org/object-oriented-programming-in-cpp/ **2.** https://onlinecourses.nptel.ac.in/noc21_cs02/preview 3. https://onlinecourses.nptel.ac.in/noc24_cs44/preview 4. C++ reference - C++98 and C++03, C++11, C++14. 5. Overview of the New C++ (C++11/14) by Scott Meyers, 2015. **6.** ISO C++ Standards.		

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T. Y. Sem V

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T. Y. B. Tech (Multidisciplinary Minor II)
Academic Year – 2025-2026 Semester –V
[CSM3201T]: Data Structures

Teaching Scheme:	Credit	Examination Scheme:
TH: - 3 Hours/Week	TH: 3	In Sem. Evaluation: 20 Marks Mid Sem. Exam : 30 Marks End Sem. Exam : 50 Marks Total : 100 Marks

Course Prerequisites : Fundamentals of Computer Programming [CS1201], Fundamentals of Data Structures [CS1202]

Course Objective:

- Analyze the asymptotic performance of algorithms.
- Allow to assess how the choice of data structures and algorithm design methods impacts the performance of programs
- To choose the appropriate data structure and algorithm design method for a specified application.
- To solve problems using data structures such as linear lists, stacks, queues, binary trees, binary search trees, and graphs, hash tables and writing programs for these solutions.

Course Outcome:

After successful completion of the course, students will able to:

CO1: Explain the basic principles of algorithms, data structures, and complexity analysis.

CO2: Explain and apply linked list operations for solving problems.

CO3: Explain and apply stack/queue operations.

CO4: Explain and use tree structures for problem-solving.

CO5: Explain and apply Use graph data structures for problem-solving.

CO6: Apply and analyze hashing techniques for computational challenges.

Course Contents

UNIT-I	Introduction to Algorithm and Analysis of Algorithms	6 Hours

Concept of Problem Solving, Introduction to Algorithms, Characteristics of Algorithms, Introduction to Data Structure, Data Structure Classification (Linear and Non-linear, Static and Dynamic, Persistent and Ephemeral data structures), Time complexity and Space complexity, Asymptotic Notation - The Big-O, Omega and Theta notation, Algorithmic upper bounds, lower bounds, Best, Worst and Average case analysis of an Algorithm, Abstract Data Types (ADT).

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UNIT-II	Linear Data Structures: Linked Lst	8 Hours
Concept of Linear Data Structures, Array as an ADT, Merging of two arrays, Storage Representation, Linear list – Operations on singly linked list, doubly linked list implementation, insertion, deletion and searching operations, circularly linked lists implementation, Operations for Circularly linked lists, applications of linked lists.		
UNIT-III	**Linear Data Structures: Stacks & Queues**	**8 Hours**
LIFO Principle, Stack as an ADT, Representation and Implementation of Stack using Sequential and Linked Organization, Applications of stack: Simulating Recursion using Stack, Arithmetic Expression Conversion and Evaluation, Reversing a String. Time complexity analysis of Stack operations **Queue data structure**: FIFO principle, Queue ADT implementation, Representation and Implementation of Linear Queue, Circular Queue, Priority Queue, Double Ended Queue. Applications: Job scheduling, Queue simulation, Categorizing data. Time complexity analysis of Queue operations. Comparison of stack and queue data structures		
UNIT-IV	**Non Linear Data Structures: Trees**	**8 Hours**
Introduction to Non Linear Data Structures, Tree- basic terminology, General tree and its representation, representation using sequential and linked organization, Binary tree- properties, converting tree to binary tree, binary tree traversals inorder, preorder, post order, level wise -depth first and breadth first, Operations on binary tree. Binary Search Tree (BST), BST operations, Height Balanced Tree- AVL tree. **Case Study: Weight balanced tree: Optimal Binary Search Tree (OBST),**		
UNIT-V	**Non Linear Data Structures: Graphs**	**8 Hours**
Basic Terminology of Graphs, Directed Graph, Undirected Graph, Various Representations, Operations on Graph (search and traversal algorithms and complexity analysis) minimum spanning tree- Prim's and Kruskal Algorithms, Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra's Algorithm		
UNIT-VI	**Hashing**	**7 Hours**
Hashing – General Idea, Hash Function, Separate Chaining, Hash Tables without linked lists: Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Hash Tables in the Standard Library, Universal Hashing, Extendible Hashing. **Case Study: Hashing in Password Management**		

Text Books:

T1. Horowitz, Sahani, Dinesh Mehata, "Fundamentals of Data Structures in C++"‖, Galgotia Publisher, ISBN: 8175152788, 9788175152786.

T2. Data Structures and Algorithms, Alfred V. Aho, John E. Hopperoft, Jeffrey D. UIlman.

T3. Michael J Folk, "File Structures an Object Oriented Approach with C++‖", Pearson Education, ISBN: 81-7758-373-5.

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Reference Books:

R1. The Art of Computer Programming: Volume 1: Fundamental Algorithms, Donald E. Knuth
R2. Introduction to Algorithms, Thomas, H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein.
R3. Open Data Structures: An Introduction (Open Paths to Enriched Learning), 31st ed. Edition , Pat Morin

Online/Web/Other References:

1. https://www.geeksforgeeks.org/data-structures/
2. https://www.coursera.org/learn/data-structures
3. https://nptel.ac.in/courses/106102064

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T. Y. B. Tech (Multidisciplinary Minor II)
Academic Year – 2025-2026 Semester –V
[CSM3201L]: Data Structures Lab

Teaching Scheme: **PR: - 2 Hours/Week**	**Credit** **PR: 1**	**Examination Scheme:** **Lab Evaluation : 50 Marks**

Course Prerequisites: Fundamentals of Computer Programming [CS1103], Fundamentals of Data Structures [CS2202]

Course Objective:

These course objectives aim to provide students with a comprehensive understanding of Advanced data structures, algorithms, and their applications in solving real-world problems.

Course Outcome:

After successful completion of the course, students will able to:

CO1: Implement linear data structures such as arrays, linked lists, stacks, and queues.
CO2: Implement non linear data structures trees and graphs for solving problems effectively .
CO3: Implement various hashing techniques.

Lab Contents

Guidelines for Assessment

1. Continuous assessment shall be based on experiments performed, submission of results of program in the form of report/journal, timely completion, attendance, understanding, efficient codes, punctuality and neatness.
2. Practical/Oral examination shall be based on the practicals performed in the lab.
3. Term work and Lab assessment of 50 marks shall be based on continuous assessment and performance in Practical/Oral examination

List of Laboratory Assignments/Experiments

1.	Design, Develop and Implement a menu driven Program in C/C++ for the following Array operations a. Creating an Array of N Integer Elements b. Display of Array Elements c. Inserting an Element at a given valid Position d. Deleting an Element at a given valid Position e. Exit.

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2.	Use a doubly linked list to create and manage a music playlist with features like adding, removing, and displaying songs in forward and reverse order.
3.	Design, Develop and Implement a menu driven Program in C/C++ for the following operations on STACK (Array Implementation of Stack with maximum size MAX) a. Push an Element on to Stack b. Pop an Element from Stack c. Demonstrate how Stack can be used to check Palindrome d. Demonstrate Overflow and Underflow situations on Stack e. Display the status of Stack f. Exit
4.	Simulate a queue system for handling customers in a bank.
5.	Implement a general tree structure to represent a family tree with basic operations like adding members, searching, and displaying relationships.
6.	Implement a Binary Search Tree (BST) to store and retrieve student records based on roll numbers.
7.	Represent a social network using graphs where nodes are people and edges are connections. Perform BFS and DFS to explore connections.
8.	Design a system to store and retrieve student marks using hashing.
9.	Create a hash table to store book records with operations like insert, search, and delete using Universal Hashing.

Text Books:

T1. Horowitz, Sahani, Dinesh Mehata, "Fundamentals of Data Structures in C++"‖, Galgotia Publisher, ISBN: 8175152788, 9788175152786.
T2. Data Structures and Algorithms, Alfred V. Aho, John E. Hopperoft, Jeffrey D. UIlman.
T3. Michael J Folk, "File Structures an Object Oriented Approach with C++‖", Pearson Education, ISBN: 81-7758-373-5.

Reference Books:

R1. The Art of Computer Programming: Volume 1: Fundamental Algorithms, Donald E. Knuth
R2. Introduction to Algorithms, Thomas, H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein.
R3. Open Data Structures: An Introduction (Open Paths to Enriched Learning), 31st ed. Edition , Pat Morin

Online/Web/Other References:

1. https://www.geeksforgeeks.org/data-structures/
2. https://www.coursera.org/learn/data-structures
3. https://nptel.ac.in/courses/106102064

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T. Y. B. Tech (Multidisciplinary Minor III)
Academic Year – 2025-2026 Semester –VI
[CS2208T]: Database Management Systems

Teaching Scheme: **TH: - 3 Hours/Week**	**Credit** **3**	**Examination Scheme:** In Sem. Evaluation:20 Marks Mid Sem. Exam: 30 Marks End Sem. Exam: 50 Marks

Course Prerequisites: Discrete Mathematics, Data Structures and Algorithms

Course Objective:

- To study the fundamental concepts, architecture, and need for database management systems over traditional file systems.
- To understand and implement relational algebra operations and design databases using Entity-Relationship (ER) diagrams.
- To develop skills in applying SQL and PL/SQL commands for efficient data definition, manipulation, and control in relational databases.
- To explore the principles of transaction management and concurrency control to maintain data consistency and enable reliable multi-user operations.

Course Outcome:
After successful completion of the course, students will able to:
CO1: Summarize the fundamental concept of database management systems.
CO2: Implement relational algebra operations and ER diagrams for database design.
CO3: Apply SQL and PL/SQL commands to manage and manipulate database systems effectively.
CO4: Use transaction management and concurrency control mechanisms to ensure data consistency, concurrency, and efficient database operations.

Course Contents

UNIT-I	**Introduction to Database Systems**	**7 Hours**

Introduction to DBMS and its need, Advantages of DBMS over file system, DBMS users and responsibilities, Architecture of DBMS: 1-tier, 2-tier, 3-tier, Data models: Hierarchical, Network, Relational, Object-Oriented, Schema and instance concepts, Data independence, Classification of DBMS, Overview of database languages (DDL, DML, DCL, TCL)
Case Study: Evaluating the Role of DBMS in a University Student Information System

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UNIT-II	Entity Relationship (ER) Modeling	8 Hours
Basic concepts: Entities, attributes, relationships, Types of attributes: Simple, composite, derived, multivalued, Relationship types: One-to-one, one-to-many, many-to-many, Enhanced ER Model: Generalization, specialization, aggregation, Weak entities and identifying relationships, Converting ER diagram to relational schema. **Case Study:** ER Diagram for Online Retail Store.		
UNIT-III	**Relational Model and Relational**	**7 Hours**
Relational model: Concepts of relation, tuple, attribute, schema, Integrity constraints: Domain, key, entity, referential, Types of keys: Super key, candidate key, primary key, foreign key, Relational algebra operations: Basic: Selection (σ), Projection (π), Union, Set difference, Cartesian product, Advanced: Join (natural, theta, outer), Division, Intersection, Rename, Expressing queries using relational algebra, Mapping ER diagrams to relational schema **Case Study: D**esign and implementation of a University Course Management System using the Relational Model, focusing on organizing data related to students, courses, faculty, departments, and enrollments into well-structured relational tables**.**		
UNIT-IV	**SQL – Structured Query Language**	**8 Hours**
DDL: CREATE, ALTER, DROP statements, DML: INSERT, UPDATE, DELETE, SELECT queries: Simple, conditional, aggregate functions, GROUP BY, HAVING, ORDER BY, Joins: Inner, outer, self joins, Set operations: UNION, INTERSECT, MINUS, Subqueries: Nested, correlated, Views and indexes, Integrity constraints in SQL, Access control in SQL: GRANT, REVOKE, Importance of normalization in design, 1NF, 2NF, 3NF, BCNF with examples, **Case Study:** Designing and Managing an Online Banking System		
UNIT-V	**PL/SQL – Procedural Language Extension to SQL**	**8 Hours**
Introduction to PL/SQL and its advantages, PL/SQL block structure: Declaration, Execution, xception handling, Data types, variables, operators, control structures, Cursors: Implicit and explicit, Exception handling: Predefined and user-defined exceptions, Stored procedures and functions, Triggers: Row-level and statement-level, Cursor: Implict, Explicit, Real-life examples and implementation using a DBMS tool (e.g., Oracle) **Case Study:** Implementation of cursors to process and retrieve records of all books borrowed by a particular user		
UNIT-VI	**Transaction Management and Concurrency Control**	**7 Hours**
Transactions: Concepts and properties (ACID), Serializability: Conflict and view serializability, Schedules and precedence graphs, Concurrency control:Lock-based protocols (2PL, Strict 2PL), Timestamp-based protocols, Optimistic concurrency, Deadlocks: Detection and prevention, Recovery techniques: Logging, checkpoint, shadow paging, Buffer management basics, Error recovery and logging, undo, redo, undo-redo logging and recovery methods. **Case Study:** A banking system processes multiple concurrent transactions. Examine how the system ensures ACID properties.		

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Text Books:

T1. Silberschatz, Henry F. Korth, and S. Sudharshan, "Database System Concepts", 7th Ed, Tata McGraw Hill, 2019.

T2. C. J. Date, A. Kannan and S. Swamynathan, "An Introduction to Database Systems", 8th ed, Pearson Education, 2006

Reference Books:

R1. Ramez Elmasri and Shamkant B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson/Addision wesley, 2017

R2. Raghu Ramakrishnan, "Database Management Systems", Third Edition, McGraw Hill, 2003

R3. S. K. Singh, "Database Systems Concepts, Design and Applications", First Edition, Pearson Education, 2006

Online/Web/Other References:

1. **https://www.geeksforgeeks.org/introduction-of-dbms-database-management-system-set-1/**
2. **https://onlinecourses.nptel.ac.in/noc22_cs91/preview**
3. **https://www.coursera.org/courses?query=database%20management**

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B.Tech. Sem VII

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B. Tech (Multidisciplinary Minor IV)
Academic Year – 2026-2027 Semester -VII
[CSM4201T]: Computer Networks

Teaching Scheme: **TH: 3 Hours/Week**	**Credit** 3	**Theory Examination Scheme:** In Sem. Evaluation: 20 Marks Mid Sem. Exam: 30 Marks End Sem. Exam: 50 Marks

Prerequisites Courses: Fundamentals of Computer Programming [CS1203]

Course Objective:

- To learn the network architecture.
- To study flow control, error detection, and error correction approaches.
- To comprehend the network's routing and addressing mechanisms.
- To understand connectionless, connection-oriented services, and network congestion.
- To learn about several protocols used at the application layer.

Course Outcome:

CO1: Choose the appropriate network topology and connecting media for configuring the network.
CO2: Select an efficient method to maximize bandwidth utilization for various LAN types.
CO3: Apply the error control and flow control techniques of the data link layer.
CO4: Make use of different IP addressing and routing protocols for network configuration.
CO5: Implement transport layer protocols to facilitate communication between different nodes.
CO6: Use application layer protocols to enable communication between application processes running on different systems.

Course Contents

UNIT-I	**Introduction and Data Communication Components**	**08 Hours**

Computer Networks and Distributed Systems, Classifications of Computer Networks, Preliminaries of Layered Network Structures. Representation of Data and Its Flow, Various Connection Topology, Protocols and Standards, OSI Model, TCP/IP Model, Transmission Media.

Case Study: Implementation of topologies using the PacketTracer tool.

UNIT-II	**LAN and Techniques for Bandwidth Utilization**	**07 Hours**

Wired LAN, Wireless LAN and Virtual LAN, Multiplexing - Frequency Division, Time Division and Wave Division, Concepts on Spread Spectrum. **Line Coding Schemes:** Manchester and Differential Manchester Encodings, Frequency Hopping (FHSS) and Direct Sequence Spread Spectrum (DSSS).
Case Study: Study College network**. Case Study: Study of College Network**

UNIT-III	**Data Link Layer**	**08 Hours**

Introduction, functions, **ARQ strategies:** Error Detection and correction, Parity Bits, Hamming Codes (11/12-bits) and CRC. **Flow Control Protocols:** Unrestricted Simplex, Stop and Wait, Sliding

Window Protocol. **MAC Sub layer:** Multiple Access Protocols: Pure and Slotted ALOHA, CSMA, WDMA, CSMA/CD, CSMA/CA. Introduction to Ethernet IEEE 802.3, IEEE 802.11 a/b/g/n, IEEE 802.15 and IEEE 802.16 Standards.
Case Study: Visualization of Flow Control Protocols on Simulator**.**

UNIT-IV	**Network Layer**	**07 Hours**

Switching Techniques: Circuit switching, Message Switching, Packet Switching, **Logical Addressing:** IPV4, IPV6, CIDR, **Address Mapping:** ARP, RARP, ICMP, IGMP, **Network Routing and Algorithms:** Static Routing, Dynamic Routing, Distance Vector Routing, Link State Routing, Path Vector. **Routing Protocols:** RIP, OSPF, BGP.
Case Study: Demonstrate the workings of the routing protocol using the packet tracer tool.

UNIT-V	**Transport Layer**	**07 Hours**

Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service (QoS), QoS Improving Techniques - Leaky Bucket and Token Bucket Algorithms.
Case Study: Implement connection-oriented communication using socket programming in Java

UNIT-VI	**Application Layer**	**08 Hours**

DNS, DDNS, TELNET, EMAIL, FTP, WWW, HTTP, SNMP, Bluetooth, Firewalls, Electronic Mail, Directory Services and Network Management.
Case Study: Study of Application Layer protocols using network protocol analyzer. e.g. Wireshark

BOOKS:

Text:

T1. Computer Networks, A. Tannenbaum, Pearson Education-Prentice Hall.
T2. T2. Data and Computer Communication, William Stallings, Pearson.

References:

R1. Forouzan B, "Data communication & Networking", 5 th edition, Tata Macgraw Hill.
R2. Kurose, Ross, “Computer Networking a Top Down Approach Featuring the Internet”, Pearson, ISBN-10: 0132856204
R3. UNIX Network Programming, Vol. 1, 2 & 3, W. Richard Stevens.

Online/Web/Other References:
1. https://www.geeksforgeeks.org/basics-computer-networking/
2. https://onlinecourses.nptel.ac.in/noc22_cs19/preview
3. https://www.coursera.org/courses?query=computer%20network

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B. Tech (Multidisciplinary Minor VII)
Academic Year – 2026-2027
[CSM4201L]: Computer Networks Lab

Teaching Scheme: **PR: 2 Hours/Week**	**Credit** 1	**Total:** 50 Marks

Prerequisites Courses: Fundamentals of Computer Programming [CS1203]

Course Objective:

- To learn the network architecture.
- To study flow control, error detection, and error correction approaches.
- To comprehend the network's routing and addressing mechanisms.
- To understand connectionless, connection-oriented services, and network congestion.
- To learn about several protocols used at the application layer.

Course Outcome:

CO1: Choose the appropriate network topology and connecting media for configuring the network.
CO2: Select an efficient method to maximize bandwidth utilization for various LAN types.
CO3: Apply the error control and flow control techniques of the data link layer.
CO4: Make use of different IP addressing and routing protocols for network configuration.
CO5: Implement transport layer protocols to facilitate communication between different nodes.
CO6: Use application layer protocols to enable communication between application processes running on different systems.

Lab Contents
Guidelines for Assessment

1) Continuous assessment shall be based on experiments performed, submission of results of program in the form of report/journal, timely completion, attendance, understanding, efficient codes, punctuality and neatness.
2) Practical/Oral examination shall be based on the practical's performed in the lab.
3) Lab assessment of 50 marks shall be based on continuous assessment, and performance in Practical/Oral examination.

List of Laboratory Assignments/Experiments	
1	Setting up a small network (2PC/4 PC) and configuration for sharing resources.
2	Setup a WAN which contains wired as well as wireless LAN by using a packet tracer tool.
3	Write a program for error detection and correction for ASCII codes using CRC.
4	Write a program to simulate Go-back-N and Selective Repeat modes of sliding window protocol.
5	Write a program using TCP socket for following:

	a. Say Hello to Each other (For all students) b. File transfer (For all students) c. Calculator (Arithmetic)
6	Write a program using UDP Sockets to enable file transfer (Script, Text, Audio and Video one file each) between two machines.
7	Write a program using TCP sockets for wired network to implement: a. Peer to Peer Chat b. Multiuser Chat.
8	Write a program using UDP sockets for wired network to implement: a. Peer to Peer Chat b. Multiuser Chat
9	Installation and configuration web server (Client-server based).
10	Design a website using HTML for any application.
11	Capture packets using Wireshark, write the exact packet capture filter expressions to accomplish the following and save the output in file: 1. Capture all TCP traffic to/from Facebook, during the time when you log in to your Facebook account 2. Capture all HTTP traffic to/from Facebook, when you log in to your Facebook account 3. Write a DISPLAY filter expression to count all TCP packets (captured under item #1) that have the flags SYN, PSH, and RST set. Show the fraction of packets that had each flag set. 4. Count how many TCP packets you received from / sent to Face book, and how many of each were also HTTP packets.

BOOKS:

Text:

T1. Computer Networks, A. Tannenbaum, Pearson Education-Prentice Hall.
T2. T2. Data and Computer Communication, William Stallings, Pearson.

References:

R1. Forouzan B, "Data communication & Networking", 5 th edition, Tata Macgraw Hill.
R2. Kurose, Ross, “Computer Networking a Top Down Approach Featuring the Internet”, Pearson, ISBN-10: 0132856204
R3. UNIX Network Programming, Vol. 1, 2 & 3, W. Richard Stevens.

Online/Web/Other References:

1. https://www.geeksforgeeks.org/basics-computer-networking/
2. https://onlinecourses.nptel.ac.in/noc22_cs19/preview
3. https://www.coursera.org/courses?query=computer%20network

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DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Multidisciplinary Minor (offered to other Departments)

Structure (Effective from 2024-25)

Course Code	Course	Teaching Scheme				Credit	Examination Scheme			Total Marks
		L	T	P	Hr	C	ISE	MSE	ESE	
S. Y. Sem IV										
ECM2201T	Digital Design & Computer Organization	3	-	-	3	3	20	30	50	100
T. Y. Sem V										
ECM3201T	Microcontroller	3	-	-	3	3	20	30	50	100
ECM3201L	Microcontroller Laboratory	-	-	2	2	1	ISCE: 30		20	50
T. Y. Sem VI										
ECM3202T	Internet of Things	3	-	-	3	3	20	30	50	100
B.Tech. Sem VII										
ECM4201T	Embedded Systems	3	-	-	3	3	20	30	50	100
ECM4201L	Embedded Systems Lab	-	-	2	2	1	ISCE: 30		20	50
Total		**12**	**-**	**4**	**16**	**14**				**500**

Abbreviations:

L – Lecture, **T** – Tutorial, **P** – Practical, **Hr**– Hours, **C** – Credits, **ISE** – In Semester Evaluation, **MSE** – Mid Semester Evaluation, **ESE** – End Semester Evaluation

Notes:

For Theory courses: There shall be MSE, ISE and ESE. The ESE is a separate head of passing.
For Lab courses: There shall be continuous assessment (ISCE consists of ISE and MSE). The ESE is a separate head of passing.

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S. Y. B. Tech (E&TC Engineering)
Academic Year – 2024-2025 Semester -IV
[ECM2201T]: Digital Design and Computer organization

Teaching Scheme:	Credit	Examination Scheme:
TH: - 03 Hours/Week	TH:03	In Sem. Evaluation :20 Marks Mid Sem. Exam :30 Marks End Sem. Exam :50 Marks

Course Prerequisites:Logic gates and Boolean algebraa, logical equation reduction technique, K-MAP.

Course Objective:

The course is served to acquaint the students with the fundamental principles of digital logic and various devices used to implement logical operations. The course provides foundation for further studies in areas such as Communication, VLSI, Computer, Microprocessor. To acquaint the students with the fundamental principles of computer and various devices used to implement logical operations. To acquaint the students with the functions of input/output devices and memory

Course Outcome:

After successful completion of the course, students will able to:

CO1: Outline features of the basic logic circuit, modules of computer
CO2: Summarize functionality of the digital logic circuit and various modules of computer.
CO3: Design combinational and sequential circuits for given task.

Course Contents

UNIT-I	Combinational Logic Design	07 Hours

Standard representations for logic functions, minimization of logical functions using k map (up to 4 variables), don't care conditions.MSI devices like Comparators, Multiplexers, Encoder , Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU , Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU.

UNIT-II	Sequential Logic Design	07 Hours

Basic design steps- State diagram, State table, State reduction, State assignment, Mealy and Moore machines representation, Implementation, finite state machine implementation, Sequence detector. Introduction to Algorithmic state machines - Construction of ASM chart and realization for sequential circuits.

UNIT-III	State Machines	07 Hours

Basic design steps- State diagram, State table, State reduction, State assignment, Mealy and Moore machines representation, Implementation, finite state machine implementation, Sequence detector. Introduction to Algorithmic state machines - Construction of ASM chart and realization for sequential

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circuits.		
UNIT-IV	**Basic structure of computer**	**07 Hours**
Computer types, functional units- input unit; output unit; ALU; control unit; memory unit, Basic operational concepts, Bus structure, Performance-processor clock; basic performance equation; pipelining & superscalar; operation; clock rate; instruction set: CISC & RISC; Multiprocessors & Multi computers		
UNIT-V	**Arithmetic & control unit**	**06 Hours**
Addition & subtraction of signed binary number, signed operand multiplication, Booths algorithm, Integer division, single bus organization- register transfer; performing an arithmetic or logic operation; fetching and storing word from/to memory; execution of complete instruction; branch instruction, multi bus organization.		
UNIT-VI	**Memory & input-output organization**	**07 Hours**
I/O organization – accessing I/O devices, Interrupts- interrupt hardware, enabling and disabling interrupts, handling multiple requests, Direct memory access- bus arbitration, Buses- Synchronous; asynchronous, semiconductor RAM memories-internal organization of memory chips; static memories; asynchronous and synchronous DRAM; structure of large memories, cache memory, virtual memory.		

Text Books:

T1 Jain, "Modern digital electronics", 3rd edition, 12threprint Tata McGraw Hill Publication, 2007.

T2 Morris Mano, "Digital Logic and Computer Design" 4th edition, Prentice Hall of India, 2013.

T3 Zvonco Vranesic and Safwat Zaky," ComputerOrganization" 5th edition Tata McGrail

T4 John P Hayes, "Computer Architecture and Organization" 3rd edition Prentice Hall of India

Reference Books:

R1. Anand Kumar, "Fundamentals of digital circuits" 1st edition, Prentice Hall of India, 2001

R2. William Stallings, "Computer Organization and Architecture: Designing for Performance" 2nd edition Prentice Hall of India

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T. Y. B. Tech (E&TC Engineering)
Academic Year – 2025-2026 Semester -V
[ECM3201T]: Microcontrollers

Teaching Scheme:	Credit	Examination Scheme:
TH: - 03 Hours/Week	TH:03	In Sem. Evaluation:20 Marks Mid Sem. Exam :30 Marks End Sem. Exam :50 Marks

Course Prerequisites:Students must have the awareness of Digital Circuits,Programming Language using C, Basics of 8051 Microcontroller.

Course Objective:
This course content provides Program PIC microcontroller for data acquisition and processing application. The objective of this course is to analyze the basic concepts and programming of PIC18F458 Microcontroller

Course Outcome:
After successful completion of the course, students will able to:
CO1: Outline various aspects of microcontroller and PIC18 architecture.
CO2: Describe optimum utilization of instructions for the given task.
CO3: Constructcode for given task in Embedded C language platform including interfacing with different peripherals.
CO4: Explore performance of developed system in terms of various measurement parameters.

Course Contents

UNIT-I	Introduction to Microcontroller	07 Hours

Microcontrollers and Microprocessor comparison, advantages and applications of Harvard and Von Neumann architecture, RISC and CISC comparison. Definition of embedded system and its characteristics, Role of microcontroller in embedded System. Limitation of 8bit microcontrollers, Study of RS232, RS485, I2C, SPI protocols, Software and hardware tools for development of microcontrollerbased system such as assembler, compiler, IDE, Emulators, debugger.

UNIT-II	Overview of the PIC18 Family	06 Hours

Overview of the PIC18 Family, Architectural block diagram,PIC18 PIN Configuration Registers. WREG Register, File Register, access Bank. Status Register, Program Counter,Memory organization, RISC Architecture in the PIC18.

UNIT-III	Classification of Instructions and I/O Port Programming	06 Hours

Addressing modes,Assembler directive- ORG, DB, EQU, END, LIST,SET, Instruction Sets: Data Transfer instructions, logical&arithmetic Instructions, branching, call, Time delay, bank switching, subroutines, Bit related instructions.

UNIT-IV	PIC18 Programming in C	07 Hours

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Data Types and Time Delays in C, I/O Programming in C, Logic Operations in C, Data Serialization in C, Program ROM Allocation in C, Data RAM Allocation in C.		
UNIT-V	**PIC18 Programming in C: Timer, Serial Port and Interrupt**	**07Hours**
Programming Timers 0, 1, 2 and 3 in C, Counter Programming, Basics of Serial Communication, PIC18 connection to RS232, PIC18 Serial Port Programming in C, PIC18 Interrupts, Programming Timer, External Hardware, Serial communication and Port B change interrupts.		
UNIT-VI	**PIC18 Programming in C: Timer, Serial Port and Interrupt**	**07 Hours**
LCD Interfacing, Keyboard Interfacing, ADC Characteristics. ADC Programming in the PIC18, DAC Interfacing,Relays and optoisolators,, Stepper Motor Interfacing, DC Motor interfacing and PWM.		

Text Books:

T1 Mohmad-ali-mazidi, Roline D. Mckinlay,"PIC microcontroller and Embedded Systems", Pearson.

T2 Mohmad John B. Peatman, "Design with PIC Micro-controllers", Pearson Education Asia, Low Price Edition, 2005 d..

Reference Books:

R1. Han-Way Huang, "PIC microcontroller: an introduction to software and hardware interfacing", Cengage Learning.

R2. Micheal Predko, "Programming and Customizing the PIC Microcontroller", McGraw-Hill publications.

R3. MICROCHIP PIC 18 Data Sheet: www.microchip.com.

NPTEL video links:

Embedded System Introduction :https://nptel.ac.in/courses/108102045
RISC and CISC Architecture :https://archive.nptel.ac.in/courses/106/105/106105163/
Introduction to PIC microcontrollers, Architecture and pipelining, program memory considerations:https://nptel.ac.in/courses/108102045
Addressing modes, CPU registers, Instruction set, simple operations:https://nptel.ac.in/courses/108102045

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T. Y. B. Tech (E&TC Engineering)
Academic Year – 2025-2026 Semester -V
[ECM3201L]: Microcontrollers Lab

Teaching Scheme:	Credit	Examination Scheme:
TH: - 2 Hours/Week	PR: 2	Lab Evaluation :50 Marks

Course Prerequisites: Students must have the awareness of Digital Circuits, Programming Language using C, Basics of 8051 Microcontroller.

Course Objective:
This course content provides Program PIC microcontroller for data acquisition and processing application. The objective of this course is to analyze the basic concepts and programming of PIC18F458 Microcontroller

Lab Outcome:

After successful completion of the course, students will able to:

LO1: Demonstrate the skills in Embedded C Language Programming of Microcontroller.
LO2: Interpret the basic knowledge of Microcontroller interfacing, delay generation, and waveform generation.
LO3: Apply the concepts of Interfacing to connect external devices with the PIC microcontroller.
LO4: Implement microcontroller based simple real time applications.

Lab Contents

Guidelines for Assessment

- Total marks assigned are 50.
- Continuous assessment will be carried out based on attendance, lab performance, and timely submission of lab file for 20 Marks, Mid semester examination 10 Marks on Viva Voce or Viva Voce + Micro project or Viva Voce + any one practical performance on the practical up to mid semester.
- Final practical examination for specific practical and oral examination will be conducted for 20 Marks.

List of Laboratory Experiments

1	Write Embedded C program to implement LED interfacing with PIC microcontroller).
2	Write Embedded C program to implement LCD interfacing with PIC microcontroller.
3	Embedded C program to implement interfacing of seven segment display with PIC microcontroller
4	Embedded C program to implement interfacing of key Matrix with PIC microcontroller.

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5	Embedded C program to implement interfacing ADC of with PIC microcontroller.
6	Write Embedded C program to implement stepper motor interfacing with PIC microcontroller.
7	Write Embedded C program to implement delay using Timers.
8	Embedded C program to implement interfacing of LM 35 Sensor.
9	Write a program to perform arithmetic operation using MPLAB.
10	Embedded C program to implement interfacing of DC Motor with PIC microcontroller.
11	Write Embedded C program to implement concept of I2C protocol.

Text Books:

T1 Mohmad-Ali-mazidi, Roline D. Mckinlay,"PIC microcontroller and Embedded Systems", Pearson.

T2 Mohmad John B. Peatman, "Design with PIC Micro-controllers", Pearson Education Asia, Low Price Edition, 2005 d.

Reference Books:

R1. Han-Way Huang, "PIC microcontroller: an introduction to software and hardware and interfacing", Cengage Learning.

R2. Micheal Predko, "Progamming and Customizing the PIC Microcontroller", McGraw-Hill publications.

R3. MICROCHIP PIC 18 Data Sheet: www.microchip.com.

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T. Y. B. Tech (E&TC Engineering)
Academic Year – 2025-2026 Semester -VI
[ECM3202T]: Internet of Things

Teaching Scheme:	**Credit**	**Examination Scheme:**
TH: - 3Hours/Week	**TH:3**	**In Sem. Evaluation:20 Marks** **Mid Sem. Exam :30 Marks** **End Sem. Exam :50 Marks**

Course Prerequisites: Microcontrollers, Embedded system and object-oriented Programming.

Course Objective:
This course provides the strong foundation of fundamentals of IOT with different sensors. Getacquainted with communication protocols on different applications of IOT Ecosystems.

Course Outcome:
After successful completion of the course, students will able to:
CO1: Summarize fundamental concepts of internet of things.
CO2: Describe various sensors and protocols to meet requirements of an industrial applications.
CO3: Design different Realtime IoT based application systems.
CO4: Analyze performance parameters of IoT based systems.

Course Contents

UNIT-I	**Overview of IOT**	**06 Hours**
Internet of Things: Need, Definition and characteristics, Architecture: client-server architecture, P2P, M2M, Physical and Logical design, Frameworks, IOT levels, IOT vs M2M, Different software and hardware platforms for development.		
UNIT-II	**Wireless Sensors and Networks**	**07 Hours**
Introduction to Wireless Sensor Network, Classification, Architecture of WSN. WSN Vs. IOT, Routing, LocalizationTypes of Sensors:displacement, velocity and motion sensors, proximity sensors, force, pressure, flow, level, temperature sensors, humidity, ph and conductivity sensors.		
UNIT-III	**Embedded Suite for IoT**	**08 Hours**
Introduction toRaspberry Piand ESP32, Architecture ofRaspberry Pi, Interfacing withsensorsand actuators, Stepper motor, DHT 11, etc. with Raspberry Pi and ESP32. APIs, Raspberry PiInterfaces, Programming, APIs / Packages, Web services, controlling embedded system-based devicesusing Raspberry Pi& ESP32).		
UNIT-IV	**Wireless Technologies and IP based protocols supporting IoT**	**08Hours**
IEEE 802.15.4, Zigbee, Wireless HART, ZWave, Bluetooth Low Energy, RFID, Zigbee.IoT Connecting Protocols:IPv4, IPv6, 6LoWPAN,CoAP, MQTT,		

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comparison of Bluetooth and BLE, CoAP and MQTT.		
UNIT-V	**Data Handling& Analytics**	**07 Hours**
Bigdata, Types of data, Characteristics of Big data, Data handling Technologies, Introduction to Hadoop and cloud computing, Role of Cloud Computing in IoT, Introduction to data Analytics, Types of Data analytics.		
UNIT-VI	**Applications of IOT**	**04 Hours**
Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Agriculture,Healthcare, Activity Monitoring, Various Real time applications of IOT- Connecting IOT to cloud.		

Lab Contents

Guidelines for Assessment

- Total marks assigned are 50.
- Continuous assessment will be carried for 25 marks based on attendance, lab performance, and timely submission of lab file.
- Final practical examination for specific practical and oral examination will be conducted 25 marks.

List of Experiments

1	Interfacing of LED with Raspberry Pi/ESP32.
2	Interfacing of Raspberry Pi/ESP32 with DHT11.
3	Interfacing sensors to Raspberry Pi/ ESP32 board (PIR, Ultrasonic).
4	Interfacing of Raspberry Pi/ESP32 to demonstrate the Traffic Signal Control.
5	Access the data pushed from sensor to cloud and apply any data analytics or visualization services.
6	Demonstrate the cloud interface with Raspberry pi/ESP32, Upload data from Environmental Sensors to Cloud Server.
7	Case Study: Different cloud platforms and development boards
8	Mini project: 1. Deploy any web application on cloud with auto scaling features. 2. Develop an application on Raspberry-Pi/ESP32 to upload the temperature and humidity data on cloud.

Text Books:

T1 ArshdeepBahga, Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2015. ISBN: 978-8173719547

T2 Olivier Hersent, David Boswarthick, and Omar Elloumi, —The Internet of Things: Key

T3 Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759

T4 Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895

Reference Books:

R1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", (CRC Press)

R2. HakimaChaouchi, — The Internet of Things Connecting Objects to the Web‖ ISBN: 978-1-84821- 140-7, Wiley Publications

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RAJARSHI SHAHU COLLEGE OF ENGINEERING
TATHAWADE, PUNE-33
(An Autonomous Institute Affiliated to Savitribai Phule Pune University,Pune)

B. Tech (E&TC Engineering)
Academic Year – 2026-2027 Semester -VII
[ECM4201T]: Embedded Systems

Teaching Scheme:	Credit	Examination Scheme:
TH: - 3 Hours/Week	TH:3	In Sem. Evaluation : 20Marks Mid Sem. Exam : 30Marks End Sem. Exam : 50Marks

Course Prerequisites: Students must have the awareness of Basics of Microcontrollers and C and C++ language.

Course Objective:
This course content providesneed and applications of ARM Microprocessors in Embedded systems. Aim to provide insight of architecture and features of ARM 7 and ARM CORTEX M4 microcontroller

Course Outcome:
After successful completion of the course, students will able to:
CO1: Define the basic aspects of embedded systems, including hardware and software components.
CO2: Describe the functionality features of various embedded processor architectures and their applications in industrial systems.
CO3: Demonstrate interfacing of ARM-based microcontrollers with on-chip peripherals and external devices.
CO4:Analyze optimum functionality of ARM7 and ARM Cortex M4 microcontrollers for specific applications.

Course Contents

UNIT-I	Introduction to Embedded Systems	07 Hours
Introduction to Embedded Systems, Architecture of Embedded System, Design Methodology, Design Metrics, General Purpose Processor, System On chip. Embedded system design and development:Embedded system design, Life-Cycle Models, Development tools, Introduction to Development Platform Trends (only introduce IDE, board Details and Application) Arduino, Beaglebone, Raspberry PI, Intel Galileo Gen 2		
UNIT-II	**ARM 7 Architecture**	**06 Hours**
ARM core data flow model, Programmers model, Registers, CPSR and SPSR, Processor modes, ARMNomenclature. LPC2148: Features, Block Diagram and Description, System Control Block, Memory Map, System Control Block (PLL and VPB divider), Pin Connect Block, GPIO, Timer Block for Delay Generation, LPC 2148 Interfacing with LED, Switches, Relay, Interfacing LCD and keypad		
UNIT-III	**Real World Interfacing with ARM7 Based Microcontroller**	**06 Hours**

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UART Programming for transmission and reception of characters, Interfacing the peripherals to LPC2148: GSM and GPS using UART, on-chip ADC using interrupt (VIC), EEPROM using I2C, on-chip DAC for waveform generation, Interfacing with ARM 7 with DHT 11 sensor and servomotor.

UNIT-IV	Introduction to ARM CORTEX M4Based Microcontroller	07 Hours

Introduction to ARM CORTEX series: CORTEX A, R, M processors, Firmware development using CMSIS Standard. Introduction to ARM CORTEX M4 microprocessor core, programmer model, Processor Modes, Memory Map, Introduction Arm Cortex-M cores, STM32F4xx Architecture, ARM STM Bus Architecture, STM32F4xx Clock and SYSCLK, Peripheral Clock, PLL clock, Interrupts and Exceptions in STM32F4xx.

UNIT-V	Real World Interfacing with Cortex M4 Based Microcontroller	07Hours

GPIO Programming, Interfacing seven segment LED, LDR and MQ3 sensor with STM32F4xx, STM32F4xx: Counters and Timers: Timer and Delay Generation, UART Programming, on chip ADC and Onchip DAC for waveform generation.

UNIT-VI	Case Studies with Cortex M Based Microcontroller	07 Hours

STM32F4xx Interfacing with accelerometer MPU 6050, Ultrasonic Sensor HC-SR04, PWM: Controlling speed and direction of DC Motor CAN Bus: Features, CAN Frame, sequence of transmitting and receiving data on CAN Bus.

Text Books:

T1 T1. K.V. Shibu, "Introduction to Embedded Systems", McGraw Hill Education India Private Limited, 2n d Edition

T2 T2. Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide – Designing and Optimizing System Software", Elsevier, 1st Edition.

T3 T3. Shujen Chen, Muhammad Ali Mazidi, Eshragh Ghaemi, "STM32 Arm Programming for Embedded Systems: Using C Language with STM32", Nucleo, Micro DigitalEd., Illustrated Edition,2018.

Reference Books:

R1. UM10139 LPC214x User manual, NXP Semiconductor

R2. RM0390 Reference manual, STM32F446xx advanced Arm®-based 32-bit MCUs

R3. Joseph Yiu, "The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors", Newnes, 3 rd Edition.

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B. Tech (E&TC Engineering)
Academic Year – 2026-2027 Semester -VII
[ECM4201L]:Embedded Systems Lab

Teaching Scheme: **TH: - 2 Hours/Week**	**Credit** **PR: 2**	**Examination Scheme:** **Lab Evaluation :50 Marks**

Course Prerequisites: Students must have the awareness of Basics of Microcontrollers and C and C++ language.

Course Objective:
This course content providesneed and applications of ARM Microprocessors in Embedded systems. Aim to provide insight of architecture and features of ARM 7 and ARM CORTEX M4 microcontroller

Lab Outcome:

After successful completion of the course, students will able to:

LO1: Demonstrate the skills in Embedded C Language Programming of Microcontroller.
LO2: Interpret the basic knowledge of Embedded controllers interfacing, delay generation and waveform generation.
LO3:Apply the concepts of Interfacing to connect external devices with LPC2148 and STM32 Series.
LO4: Implement Embedded system based simple real time applications.

Lab Contents

Guidelines for Assessment

- Total marks assigned are 50.
- Continuous assessment will be carried out based on attendance, lab performance, and timely submission of lab file for 20 Marks, Mid semester examination 10 Marks on Viva Voce or Viva Voce + Micro project or Viva Voce + any one practical performance on the practical up to mid semester.
- Final practical examination for specific practical and oral examination will be conducted for 20 Marks.

List of Laboratory Experiments

1	Write a program for LPC2148 interfacing with LED and 7 segment display
2	Write a program for LPC2148 interfacing with temperature sensor and relay
3	Interfacing 16 X 2-character LCD display and Keypad with ARM LPC 2148 Microcontroller to display the key pressed
4	Write a program for LPC2148 interfacing with ADC
5	Write embedded C program to use timer block of LPC 2148 along with Switches to generate suitable delay to toggle LEDs

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6	Demonstrate DC Motor Speed Control Using PWM and Potentiometer
7	Understanding of HAL library concept and familiarization of STM32 cube IDE by blinking LED.
8	Design a four-digit binary counter that increments continuously while the switch is pressed and pauses when the button is released. Display the count using LEDs (4Nos
9	LED and button interfacing using a microcontroller (Methods- Interrupt and Polling)
10	Interfacing of LCD with STM32 microcontroller.
11	Interfacing o Temperature sensor with STM32 microcontroller

Text Books:

T1 K.V. Shibu, "Introduction to Embedded Systems", McGraw Hill Education India Private Limited, 2n d Edition

T2 Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide – Designing and Optimizing System Software", Elsevier, 1st Edition.

T3 Shujen Chen, Muhammad Ali Mazidi, Eshragh Ghaemi, "STM32 Arm Programming for Embedded Systems: Using C Language with STM32", Nucleo, Micro DigitalEd., Illustrated Edition,2018.

Reference Books:

R1. UM10139 LPC214x User manual, NXP Semiconductor

R2. RM0390 Reference manual, STM32F446xx advanced Arm®-based 32-bit MCUs

R3. Joseph Yiu, "The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors", Newnes, 3 rd Edition.

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S. Y. B. Tech
Multidisciplinary Minor I (SEM-IV)
[CEM2201T] Basic Civil Engineering

Teaching Scheme:	Credit	Examination Scheme:
TH: 3 Hours/week	3	In Sem. Evaluation: 20 Mid Sem. Exam : 30 End Sem. Exam : 50

Course Prerequisites: Fundamentals of environmental science, basic knowledge of physical quantities with their units.

Course Objective:
The main objective is to focus on building components, building planning principles, and modern tools for surveying, knowledge associated with different areas of Civil Engineering with an interdisciplinary approach, and also to make students aware of natural resources, environment protection and sustainability in construction.

Course Outcome:
After successful completion of the course, students will able to:
CO1: Explain the role of civil engineers in different areas of Civil Engineering with interdisciplinary approach.
CO2: Identify different construction materials and components of a structure.
CO3: Make use of modern surveying tools and techniques.
CO4: Utilize various principles of building planning and the concept of green building.
CO5: Categorize types of energy and environmental pollution.
CO6: Apply the concept of environment and the role of civil engineers in sustainable development.

Course Contents

UNIT-I	Introduction to Civil Engineering	06 Hours
Basic Areas in Civil Engineering, Agencies involved in Civil Engineering, Smart city concept. Interdisciplinary approach in Civil Engineering Projects. Data management for infrastructural development like traffic management.		
UNIT-II	**Materials and Construction**	**06 Hours**
Basic construction materials, Recycling of materials, Identification of Eco-friendly materials and Smart materials in construction, Substructure and Superstructure, Earthquake concepts and precautions, and construction techniques for earthquake resistance.		
UNIT-III	**Surveying**	**06 Hours**
Principles of survey, types of Benchmarks and leveling, Determination of RLs by HI, and Rise & Fall method Contours. Introduction to Modern tools and techniques for Surveying; Digital level, Theodolite EDM, Total station, Digital planimeter. Applications of GPS, GIS, and Unmanned Aerial		

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Vehicle(UAV)like Drone. Study of land-related documents.

UNIT-IV	Planning for the Built Environment	06 Hours

Principles of planning, the concept of Green buildings. Role of by-laws in regulating the environment, Concept of built-up area, carpet area, plinth area. Plot area, FSI. Fire safety norms as per NBC.

UNIT-V	Energy and Environmental Pollution	06 Hours

Conventional and non-conventional Energy Sources. Sources, causes, effects, and remedial measures of Pollution. Introduction and Disposal Methods of Solid Waste Management and Electronic wastes.

UNIT-VI	Sustainable Development for Environmental Protection	06 Hours

Sustainable development. Urbanization and its effects on the environment. Environmental ethics, human rights, value education, Environmental Impact Assessment (EIA). Concepts of water conservation techniques and its management.

Text Books:

T1. Basic Civil and Environmental Engineering by C.P Kaushik, S.S. Bahavikatti, Anubha Kaushik.
T2. Basic Civil and Environmental Engineering by M.PWagh,P.R.Modale,A.H.Shirke,SharadPagar.

Reference Books:

R1. Basic Civil Engineering by M.S. Palanichamy Tata McGraw Hill publishing Co.Ltd.
R2. Basic Civil Engineering by Shatheesh Gopi – Pearson.
R3. Building Construction by Arora S.P. and Bindra S.P. – Dhanpatrai and Sons, Delhi.
R4. Environmental Studies from Crisis to cure – Oxford Publication, Third edition, 2016.
R5. Environmental Studies by Dr. J.P. Sharma – University Science Press.IS Code:

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T. Y. B. Tech
Multidisciplinary Minor II (SEM-V)
[CE3201T] Building Materials

Teaching Scheme:	Credit	Examination Scheme:
TH: 3 Hours/week	3	In Sem. Evaluation : 20 Mid Sem. Exam : 30 End Sem. Exam : 50

Course Prerequisites: Building components, Green Building, Sustainable Building Concepts

Course Objective: To make aware about various components of building and their function. The aim is to introduce materials and activities of construction from foundation to finishing of building and also describe importance of the building services, circulation and safety aspects.

Course Outcome:

After successful completion of the course, students will able to:

CO1: Understand details of building components, masonry and protective coating with respect to its functional requirement.
CO2: Identify suitability of form work, underpinning and scaffolding.
CO3: Describe various types of casting methods of concrete, it's curing and prefabrication.
CO4: Study suitable types of roofing and flooring materials and design staircase according to functional requirement of building.
CO5: Summarize building services and vertical circulation.
CO6: Describe safety aspects to be adopted at construction site.

Course Contents

UNIT-I	Building Construction and Masonry	06 Hours

Building components and their basic requirements i.e. substructure and Superstructure requirements. Introduction to automation in construction, Masonry– Introduction of stone masonry and brick masonry, characteristics of good building bricks, IS specification and tests, classification of bricks, types of bonds: English, Flemish, Header, Stretcher, construction procedure. Recent trends in light weight construction
Protective Cladding.

UNIT-II	Partition Wall, Form work, Underpinning and Scaffoldings	06 Hours

Types of partition wall (metal, wooden, Gypsum) Slip form work: Component parts- design criteria. Mivan shuttering, Underpinning. Scaffolding: Purpose, types. Nano Materials and Technologies- Carbon nanotubes, silicon Dioxide nanoparticles, Titanium Dioxide nanoparticles

UNIT-III	Casting Procedure of Concrete and Curing Methods	06 Hours

Form Work and Casting procedure for reinforced concrete columns, beams and slabs. Methods of

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Curing (Chemical Curing using Admixtures), Precast and pre-stressed concrete work, Standardization and
Prefabrication to reduce cost. Construction Joints in concrete work.

UNIT-IV	Building Components and Materials	06 Hours

Types of flooring and its functional requirement, floor materials and finishes. Factory floor tremix, laser flooring. Types of roof and its functional requirement. Roofing materials. Doors, Windows, Arches and Lintels Types of Doors, Windows, Arches and Lintels-Definition, installation, specifications. Fixtures and fastenings. Ventilators: Purpose and types.

UNIT-V	Building Services and Vertical Circulation	06 Hours

Building services- plumbing services, lighting, ventilation, noise and acoustics, communications, smart and intelligent services. Vertical Circulations: design consideration, Types of staircase, and details of ramps, Steps, Ladders, lifts, and escalator. Fire escape staircase, Design of Doglegged staircase.

UNIT-VI	Safety on Construction Sites	06 Hours

Safety on sites, storage of materials, construction safety, fire proof construction. Planning considerations for Disaster Management. Introduction to "Building and Other Construction Workers" Act

Text Books:

T1 B. C. Punmia, Building construction, LaxmiPublications.
T2 S.V. Deodhar ,Building Materials, Khanna Publication.
T3 Bindra and Arora, Building Construction, DhanpatRai Publications
T4 S.K. Duggal , Building Materials, New Age International Publishers.
T5 S. C. Rangwala, Building Construction, Charotdar Publications.

Reference Books:

R1 Building Services Engineering by David V. Chadderton, (sixth edition or latest edition), London and New York.
R2 Civil Engineering Materials by Neil Jackson and Ravindra K. Dhir, Palgrave Macmillan.
R3 National Building Code -2016 (Latest)
R4 Building Design and construction by Frederick Merrit, Tata McGraw Hill.
R5 Times Saver Standards of Architectural Design Data by Callender, Tata McGraw Hill.
R6 Development plan and DCP Rules of urban local body, Volume 12, New Delhi.
R7 Model Building bye laws by MoUD, GoI.
R8 Civil Engineering Materials by TTTI Chandigrrah, Tata McGraw Hill Publications
R9 Materials of construction by D.N. Ghose, Tata McGraw Hill.
R10 The construction of buildings, Seventh edition, Vol. I and Vol. 2 by R. Barry, Oxford: Blackwell science
R11 Building Materials Technology by Ruth T. Brantley and L. Reed Brantley, Tata McGraw Hill.
R12 Properties of Concrete by A.M. Neville, Pearson Education Limited.
R13 Mitchell's Advanced Building Construction: The Superstructure by J. Sroud Foster

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T. Y. B. Tech

Multidisciplinary Minor II Lab (SEM-V)

[CEM3201L] Building Materials Lab

Teaching Scheme: LAB: -2 Hours/Week	**Credit: 02**	**Lab Evaluation** In Sem Evaluation: 30 marks: End Sem. Exam : 20 Marks

Course Prerequisites: Basic Civil Engineering

Course Objective: This course aims to enable students for project planning and analysis. The aim is to make the students aware about material procurement, acts in construction industry along with safety in construction.

Course Outcome:

After successful completion of the course, students will able to:

LO1: Understand details of building components, Masonry and Protective Coating with respect to itsfunctional requirement.

LO2: Identify suitability of Form work, underpinning and Scaffolding.

LO3: Describe various types of casting methods of concrete, it's curing and prefabrication.

LO4: Select suitable types of Roofing and flooring materials and design staircase according to functional requirement of building.

LO5: Summarize building services and vertical circulation.

LO6: Describe safety aspects to be adopted at construction site.

Lab Contents

Guidelines for Assessment

In Semester Continuous Evaluation and End Semester Examination (oral) is based on solved laboratory assignments.

List of Laboratory Assignments/Experiment

1	To understand and apply different bonding patterns in brick masonry
2	To set up and inspect a basic scaffolding system following safety standards
3	To explore precasting and prefabrication in construction
4	To install and evaluate different flooring materials for durability
5	To design and construct a scaled model of a dog-legged staircase
6	To identify potential hazards and implement safety protocols on a simulated construction site.

Text Books:

T1 **B. C. Punmia, Building construction, Laxmi Publications.**

T2 **S.V. Deodhar, Building Materials, Khanna Publication.**

T3 **Bindra and Arora, Building Construction, Dhanpat Rai Publications**

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T4 **S.K. Duggal, Building Materials, New Age International Publishers.**
T5 **S. C. Rangwala, Building Construction, Charotdar Publications**.

Reference Books:

R1. Construction Project Management Theory & practice --- Kumar Neeraj Jha,Pearson,2012

R2. Construction project scheduling and control ----Mubarak, Wiley India.

R3. Real Estate, Finance and investment, Bruggeman. Fishr, McGraw Hill, 2010.

R4. Construction Planning, Equipment and methods – Peurifoy-Tata McGraw Hill Publication

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Multidisciplinary Minor III (SEM-VI)
[CEM3202T] Automation in Civil Engineering

Teaching Scheme:	Credit	Examination Scheme:
TH: 3 Hours/week	3	In Sem. Evaluation : 20 Mid Sem. Exam : 30 End Sem. Exam : 50

Course Prerequisites: Basic civil engineering and Building materials

Course Objective:

- To enlighten students about different new and advanced construction and building techniques available around the globe
- To study various terminologies used in construction machinery.
- To get knowledge about application of automations and use of robots in construction.

Course Outcome:

After successful completion of the course, students will able to:

CO 1: Comprehend the application of building management system and automation in on- and off-site projects.
CO 2: Learn different characteristics of different construction equipment.
CO 3: Study the details about off and on-site automation in construction.
CO 4: Study the concept of building automation.
CO 5: Acquire knowledge about the Application of Robotics in Construction
CO 6: Learn the concept of aerial and satellite surveying.

Course Contents

UNIT-I	Introduction to Civil Engineering	06 Hours
Concept and application of Building Management System (BMS) and Automation, requirements and its effect on functional efficiency of building automation system, architecture and components of BMS- Review and analysis of state- of –art in construction automation		
UNIT-II	**Materials and Construction**	**06 Hours**
Introduction to Conventional construction methods Vs Mechanized methods and advantages of latter. Various equipment's used in construction sector		
UNIT-III	**Off and on-site automation in construction**	**6 Hours**
Off- site automation in construction Information processing (computer applications), materials processing, case study (concrete batch plant) - Existing and prototype equipment for construction – case study (concrete placement and finishing).		

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UNIT-IV	Building Automation	6 Hours
Introduction to building automation systems – components– Heating, ventilation, and air conditioning (HVAC)– Lighting – Electrical systems water supply and sanitary systems– Fire safety – security - Communication and office automation system -Water pump monitoring & control - Control of Computerized HVAC Systems		
UNIT-V	**Robotics in Construction**	**6Hours**
Automation and robotic technologies for customized component, module and building prefabrication, Elementary technologies and single – Task construction robots - Site automation robotic on- site factories.		
UNIT-VI	**Aerial and Satellite Surveying**	**6Hours**
GIS and GPS in Construction; use of Drones for spread out sites; Use of robots for repetitive activities.		

Reference Books:

R1. Javad Majrouhi Sardroud, (2011), "Automated Management of Construction Projects" LAP Lambert Academic Publishing.
R2. Construction Planning and Equipment - R. L. Peurifoy - Tata McGraw Hill, New Delhi 2.
R3. Wang Shengwei, (2010), "Intelligent Buildings and Building Automation" Taylor & Francis Group.
R4. Majrouhi Sardroud Javad, (2014), "Automation in Construction Management" Scholars' Press.
R5. Construction Equipment & Planning and Application. - Mahesh Verma Artec Publication.
R6. GPS satellite surveying- Alfred Leick, Wiley

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B. Tech
Multidisciplinary Minor IV (SEM-VII)
[CEM4201T] Construction Management

Teaching Scheme:	Credit: 03	Examination Scheme:
TH: - 3 Hours/Week		**Theory** In Sem. Evaluation : 20 Marks Mid Sem. Exam : 30 Marks End Sem. Exam : 50 Marks

Course Prerequisites: Basic Civil Engineering

Course Objective: This course aims to enable students for project planning and analysis. The aim is to make the students aware about material procurement, acts in construction industry along with safety in construction.

Course Outcome:
After successful completion of the course, students will able to:
CO1: explain various concepts related to construction projects and management
CO2: describe project scheduling techniques
CO3: perform project network analysis through scheduling methods
CO4: identify the concept of material procurement and management
CO5: execute the knowledge of legal aspects involved in construction sector
CO6: express the concept of construction safety management.

Course Contents

UNIT-I	Construction Management	06 Hours
History and Principles of management, Construction team, activities, Need and Importance of management in project. Project Management - Basic forms and functions of organization. Role of planning department in construction projects. Roles and responsibilities of project managers, Construction Project life cycle		
UNIT-II	**Project Scheduling**	**06 Hours**
Bar-Charts, S-Curve, Work-breakdown-structure, Network Scheduling – History, basic terms and advantages, types of network, Time estimate, Floats, Critical path. Introduction to Network compression and updating, Concept of resource allocation, Introduction to precedence network		
UNIT-III	**Network Analysis**	**06 Hours**
Bar chart, Critical Path Method(CPM), Program Evaluation and Review Technique(PERT),Precedence Network Analysis and applications		
UNIT-IV	**Material Management**	**06 Hours**

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Importance and functions of Materials Management, Inventory analysis - Inventory Control techniques – Inventory models – ABC analysis, Economic order quantity (EOQ) technique, Material procurement and its management		
UNIT-V	**Legal aspects: Acts and Laws**	**06 Hours**
Important acts and laws related with construction industries - factory act, the employees provident fund act, minimum wages act, workmen's compensation act, Indian trade union act, arbitration act, child labour act, RERA		
UNIT-VI	**Safety in construction**	**06 Hours**
Construction Safety Management – duties and responsibilities of top management, role of safety officers, responsibilities of general employees, safety committee, safety training, various safety equipments, personal protective equipments (PPE) used on site, First aid on site, Safety awareness programs, introduction to occupational insurance.		

Text Books:

T1. Projects planning, Analysis Selection, Implementation and Review, Prasanna Chandra - Tata McGraw Hill, New Delhi, 2005

T2. Construction Project Management Planning, Scheduling and Controlling- Chitakara - Tata McGraw Hill, New Delhi

T3. "Safety management" – Girimaldi and Simonds, AITBS, New Delhi

Reference Books:

R1. Construction Project Management Theory & practice --- Kumar Neeraj Jha,Pearson,2012

R2. Construction project scheduling and control ----Mubarak, Wiley India.

R3. Real Estate, Finance and investment, Bruggeman. Fishr, McGraw Hill, 2010.

R4. Construction Planning, Equipment and methods – Peurifoy-Tata McGraw Hill Publication

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B. Tech
Multidisciplinary Minor IV (SEM-VII)
[CEM4201L] Construction Management Lab

Teaching Scheme: LAB: -2 Hours/Week	**Credit: 02**	**Lab Evaluation** In Sem Evaluation: 30 Marks: End Sem. Exam : 20 Marks

Course Prerequisites: Basic Civil Engineering

Course Objective: This course aims to enable students for project planning and analysis. The aim is to make the students aware about material procurement, acts in construction industry along with safety in construction.

Course Outcome:
After successful completion of the course, students will able to:
LO1: explain various concepts related to construction projects and management
LO2: describe project scheduling techniques
LO3: perform project network analysis through scheduling methods
LO4: identify the concept of material procurement and management
LO5: execute the knowledge of legal aspects involved in construction sector
LO6: express the concept of construction safety management.

Lab Contents

Guidelines for Assessment

In Semester Continuous Evaluation and End Semester Examination(oral)is based on solved laboratory assignments.

List of Laboratory Assignments/Experiment

1	Preparing Work Breakdown Structure (WBS) of Project
2	Assignment on Bar chart and Critical Path Method(CPM).
3	Assignment on Program Evaluation and Review Technique (PERT).
4	Assignment on Precedence Network Analysis (PNA)
5	Assignment on ABC Analysis and EOQ Model.

Text Books:
T1. Projects planning, Analysis Selection, Implementation and Review, Prasanna Chandra - Tata McGraw Hill, New Delhi, 2005
T2. Construction Project Management Planning, Scheduling and Controlling- Chitakara - Tata McGraw Hill, New Delhi
T3. "Safety management" – Girimaldi and Simonds, AITBS, New Delhi**T4** .Jan A. Van Der Westhuizen , Drawing for Civil Engineering.

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Reference Books:

R1. Construction Project Management Theory & practice --- Kumar Neeraj Jha,Pearson,2012

R2. Construction project scheduling and control ----Mubarak, Wiley India.

R3. Real Estate, Finance and investment, Bruggeman. Fishr, McGraw Hill, 2010.

R4. Construction Planning, Equipment and methods – Peurifoy-Tata McGraw Hill Publication

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Department of Mechanical Engineering
Multidisciplinary Minor
Structure-2023

Course Code	Course	Teaching Scheme				Credit	Examination Scheme			Total Marks
		L	T	P	Hr	Cr	ISE	MSE	ESE	
S. Y. SEM-IV										
MEM2201T	Material Science & Engineering	3	-	-	3	3	20	30	50	100
T. Y. SEM-V										
MEM3201T	Manufacturing Technology	3	-	-	3	3	20	30	50	100
MEM3201L	Manufacturing Technology Lab	-	-	2	2	1	ISCE: 30		20	50
T. Y. SEM-VI										
MEM3202T	CAD/CAM	3	-	-	3	3	20	30	50	100
B. Tech. SEM-VII										
MEM4201T	Automobile Engineering	3	-	-	3	3	20	30	50	100
MEM4201L	Automobile Engineering Lab	-	-	2	2	1	ISCE: 30		20	50
	Total	**12**	**0**	**4**	**16**	**14**				**500**

Abbreviations:
L – Lecture, T – Tutorial, P – Practical, Hr – Hours, C – Credits, TuT – Tutorial, ISE – In Semester Evaluation, MSE – Mid Semester Evaluation, ESE – End Semester Evaluation

Notes:

1. **For Theory courses: There shall be MSE, ISE and ESE. The ESE is a separate head of passing.**
2. **For Lab courses: There shall be continuous assessment (ISCE consists of ISE and MSE). The ESE is a separate head of passing.**

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S. Y. B. Tech (Mechanical Engineering)

Semester -IV

[MEM2201T]: Material Science & Engineering

Teaching Scheme: **TH:03 Hours/Week**	**Credit** **TH: 03**	**Examination Scheme:** **In Sem. Evaluation:30 Marks** **Mid Sem. Exam: 20 Marks** **End Sem. Exam: 50Marks** **Total:100 Marks**

Course Prerequisites:

Course Objectives: Understanding of the structure and properties of materials, and the relationships between microstructure, characterization, and design and processing of materials.

Course Outcomes:

After successful completion of the course, students will able to:

CO1: Understanding of the applications of materials in engineering, their processing and design issues
CO2: Understanding of the structure of engineering materials and how it relates to materials' properties and behavior
CO3: Understanding of Solidification, Phase Diagram, Iron Carbon system
CO4: Understanding of Ferrous and Non-ferrous Materials
CO5: Understanding Mechanical behavior of materials
CO6: Understanding Structural materials and Powder Metallurgy
CO7: Understanding Electrical, magnetic and optical properties of materials
CO8: Elementary appreciation of the environmental and societal aspects of engineering materials

Course Contents

UNIT-I	**Structure and Mechanical Behaviour of Materials**	**10 Hours**

Introduction (history, relevance, usefulness to students' careers); Atomic structure; Chemical bonding; Structure of materials (3) Unit cell, crystalline and amorphous structures, Crystal structures (BCC, FCC and HCP systems), Bravais Lattice, Lattice parameters, indexing of lattice planes & directions, coordination number, no. of atoms per unit cell, atomic packing factor, density.(3) Bragg's law, Point defects; Hume-Rothery rules; Edge and screw dislocations; Burgers vectors; (2) Dislocation motion; Grain boundary; Twin boundary; Stacking faults (2)

UNIT-II	**Diffusion in solids**	**03 Hours**

Fick's laws; Steady-state and non-steady-state diffusion; Factors influencing diffusion; Industrial application

UNIT-III	**Solidification, Phase Diagram, Iron Carbon system**	**09 Hours**

Phase rule; Single component systems; Binary phase diagrams; Microstructural changes during cooling (Homogenous and Heterogeneous Nucleation, crystal Growth) Tie-line; Lever rule; Eutectic, peritectic, eutectoid, peritectoid changes; Phase Diagram: Fe-C phase diagram, , Applications of phase diagrams

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(3) Solidification; Nucleation and grain growth; Homogeneous and heterogeneous nucleation; Kinetics of nucleation and growth; TTT; CCT; (3) Phase transformations in Fe-C alloys: Pearlite, Bainite, Martensite, influence of alloying elements; Precipitation hardening; Glass transition (3) (Annealing and its types, Normalizing, Hardening, Tempering, Martempering, Aus tempering, Hardenability, surface hardening methods like Carburizing cyaniding, nitriding flame hardening and induction hardening, precipitation hardening)

UNIT-IV	**Ferrous and Non-ferrous Materials**	**02 Hours**

Properties, composition and uses of Grey cast Iron, malleable iron, S.G. iron and steel, Copper alloys, Brasses and Bronzes. Aluminium alloys- Cast Alloys and Wrought alloys, AISI & BIS designation of steels, Color Coding of Material

UNIT-V	**Mechanical behavior of materials**	**09 Hours**

Mechanical properties; Stress and strain; Elastic and plastic deformation; Tensile, compression, hardness and impact testing; Design/safety factors; Slip systems; (3) Mechanisms of strengthening in metals: Strain hardening; Cold and hot working; Annealing; Recovery, recrystallization, grain growth; (3) Ductile and brittle fracture; Fracture mechanisms; Methods of protection against fracture; S-N curve; Factors affecting fatigue life; Creep; Creep-resistant materials (3)

UNIT-VI	**Structural materials and Powder Metallurgy**	**06Hours**

Polymers, ceramics and composites: Structure, properties and processing (3) Powder Metallurgy: Consolidation; Sintering: theory and practice; Materials for powder metallurgy; Design of powder metallurgy processes and parts (3)

UNIT-VII	**Electrical, magnetic and optical properties**	**03Hours**

Electrical conductivity; Band structure of solids; Single crystal growth (Czochralski method); Photolithography; Relationship between absorption and bandgap; Luminescence, Fluoroscence, Phosphorescence; Classification of magnetic materials; Basic concepts; Metallic and ceramic magnetic materials

UNIT-VIII	**Corrosion, oxidation, and environmental and societal issues**	**03Hours**

Electrochemical considerations; Types of corrosion; Protection against corrosion; Oxidation mechanisms; Oxidation resistant materials; Materials life cycle assessment; Recycling and end-of-life disposal of various materials

Text Books:

R1. R. Balasubramanian, Callister's Materials Science and Engineering, Wiley India Pvt. Ltd, 2nd Ed.

Reference Books:

R1. V. Raghavan, Materials Science And Engineering, Prentice-Hall of India Pvt. Ltd, 6th Ed., 2015.

On-line Recourses: https://archive.nptel.ac.in/courses/113/102/113102080/

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T. Y. B. Tech (Mechanical Engineering)

Semester -V

[MEM3201T]: Manufacturing Technology

Teaching Scheme:	Credit	Examination Scheme:
TH:03 Hours/Week	TH: 03	In Sem. Evaluation:30 Marks Mid Sem. Exam: 20 Marks End Sem. Exam: 50Marks Total:100 Marks

Course Prerequisites: Workshop practices

Course Objectives:

To gain theoretical and practical knowledge in material casting processes and develop an understanding of the dependent and independent variables which control materials casting in a production setting. Introduce students to good foundry practices and product design considerations. Provide an overview of joining processes; discuss in detail the weld the welding process and the physics of welding. Introduce students to different welding processes weld testing and advanced processes to be able to appreciate the practical applications of welding.

Course Outcomes:

After successful completion of the course, students will able to:

CO1: Select appropriate conventional and non-conventional manufacturing processes in modern industrial practice

CO2: Understanding of the manufacturing processes related to all major material classes: metals, polymers, ceramics, and their composites

CO3: Apply interrelationships between product design and manufacturing, as well as of emerging manufacturing issues such as environmental sustainability

CO4: Apply knowledge of machining processes to analyze and improve manufacturing operations.

CO5: Understand the principles, applications, and advantages of non-conventional machining processes.

CO6: Understand the characteristics and manufacturing processes of non-metallic materials.

Course Contents

UNIT-I	COURSE OVERVIEW; CASTING	06 Hours

Brief overview of course; Introduction to casting: basic process and it's variations; Metallurgical characteristics; Major defects and their causes, inspection; Product design considerations for manufacturability

UNIT-II	JOINING	06 Hours

Introduction to welding and its types; Weldability; Metallurgical characteristics; Major defects and their causes, inspection; Brazing, soldering and adhesive bonding; Mechanical assembly; Product design aspects

UNIT-III	FORMING	07 Hours

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Introduction to forming and its major types; Analysis of forming processes; Precision forming processes; Major defects and their causes, inspection; Tool/die life considerations; Product design issues for manufacturability		
UNIT-IV	**MACHINING**	**09 Hours**
Introduction to machining processes and their variations; Fundamentals of machining: types of chips; Orthogonal cutting; Mechanics of machining and thermal issues; Cutting tools: geometry and materials; Cutting fluids; Machinability, tool wear and tool life; Abrasive machining processes; Product design and manufacturability considerations		
UNIT-V	**NON-CONVENTIONAL MACHINING**	**04 Hours**
Introduction to categories of non-conventional machining processes based on energy: mechanical, electrochemical, thermal, chemical; Material removal mechanism, advantages and limitations of different processes; Product design aspects		
UNIT-VI	**MANUFACTURING WITH NON-METALLIC MATERIALS**	**9 Hours**
Introduction to fabrication methods for polymer-based products; Processing details, mold/die design issues; Manufacturing of polymer matrix composites; Rubber products processing; Ceramics processing; Product design for manufacturability		
UNIT-VII	**MISCELLANEOUS MANUFACTURING PROCESSES**	**4 Hours**
Advanced topics in manufacturing technology: additive manufacturing, semiconductor device processing, sustainable manufacturing		

Text Books:

T1. Mikell. P. Groover "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems" John Wiley & Sons.
T2. Serope Kalpakjian and Stephen R. Schmid, "Manufacturing Engineering and Technology", Pearson Publications
T3. Manufacturing Science, A Ghosh and A K Mallik, East-West Press, 2008 (Reprint), ISBN: 81-85095-85-X.
T4. Manufacturing Technology: Foundry, Forming and Welding, P N Rao, Tata McGraw Hill, 2008.

Reference Books:

R1. G K Lal, Introduction to Machining Science, New Age International Pvt Ltd., 2007.
R2. Mechanical Metallurgy, George E. Dieter, SI Metric Edition (3rd), McGraw-Hill, 1989, ISBN: 0-07-100406-8. (*Only Part-IV of the book)

On-line Recourses: https://nptel.ac.in/courses/112/105/112105126

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T. Y. B. Tech (Mechanical Engineering)

Semester -V

[MEM3201L]: Manufacturing Technology Lab

Teaching Scheme:	Credit	Examination Scheme:
LAB:02 Hours/Week	LAB: 01	ISCE: 30 Marks ESE: 20 Marks Total: 50 Marks

Course Prerequisites :

Course Objectives:

To gain theoretical and practical knowledge in material casting processes and develop an understanding of the dependent and independent variables which control materials casting in a production setting. Introduce students to good foundry practices and product design considerations. Provide an overview of joining processes; discuss in detail the weld the welding process and the physics of welding. Introduce students to different welding processes weld testing and advanced processes to be able to appreciate the practical applications of welding.

Course Outcomes:

After successful completion of the course, students will able to:
CO1: Understand the Patterns and Pattern making & Moulding
CO2: Analyse Casting Processes
CO3: Understand Melting, Pouring and Testing
CO4: Understand Basic Joining Processes
CO5: Remember Special Welding Processes
CO6: Understand Weldments Testing

Lab Contents

Guidelines for Assessment

Practical/Oral examination based on the practical's performed in the lab. The Performance will be assessed jointly by internal and external examiners.

- Total marks for Assessment 25
- It should be continues assessment where performance is judged based on the performances
- Practical/Oral at the end of semester TW 25+ PR25 Total 50 to be recommended

List of Laboratory Experiments

1	Design of pattern & pattern making, At least one wooden pattern with proper calculations
2	Making a green sand mould, One mould each on pit Moulding & split pattern
3	Study, understanding and working of simple destructive & non-destructive testing procedures used for castings
4	Melting of metal in furnace
5	Study, understanding and working of simple destructive & non-destructive testing procedures used for welding
6	Preparation of specimen & welding of: Angle joint / T joint Lap joint / Butt joint

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7	Study on influence of welding parameters in Arc & Gas welding with demonstration

Text Books:

T1. Lindberg,"Processes and Materials of Manufacture", Prentice hall India (p) Ltd.
T2. P.N.Rao, "Manufacturing Technology", TMH Ltd 1998(Revised edition)
T3. Richard L. Little, "Welding& Welding Technology", Tata Mc Graw Hill.

Reference Books:

R1. Banga T.R; and Agrawal R.L, "Foundry Engineering", Khanna Publishers
R2. AWS Welding Hand Book,Vol 1 to 4 AWS.

On-line Recourses:

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T Y B. Tech (Mechanical Engineering)

Semester -VI

[MEM3202T]: CAD/CAM

Teaching Scheme:	Credit	Examination Scheme:
TH:03 Hours/Week	TH: 03	In Sem. Evaluation:30 Marks Mid Sem. Exam: 20 Marks End Sem. Exam: 50Marks Total:100 Marks

Course Prerequisites :

Course Objectives:

To provide an overview of how computers are being used in design, development of manufacturing plans and manufacture. To understand the need for integration of CAD and CAM and CAE

Course Outcomes:

After successful completion of the course, students will able to:

CO1: Explain fundamentals of CAD/ CAM/CAE
CO2: Understand geometric transformation techniques in CAD.
CO3: Discuss CAD modelling, curves and surfaces Techniques and Tools
CO4: Solve and understand the FEA process and its problems
CO5: Understand Computer aided planning & quality control
CO6: Demonstrate CFD process and applications

Course Contents

UNIT-I	Introduction	07Hours

Fundamentals of CAD/ CAM, Application of computers for Design and Manufacturing, Benefits of CAD/ CAM - Computer peripherals for CAD/ CAM, Design workstation, Graphic terminal, CAD/ CAM software- definition of system software and application software, CAD/ CAM database and structure. Data Exchange formats.CAD/CAE process and applications, CAD based reverse engineering

UNIT-II	Computer Graphics	07Hours

Graphics standards, Graphics Software, Software Configuration,Graphics Functions, Output primitives-Bresenham's line drawing algorithm and Bresenham's circle generating algorithm Geometric Transformations: World/device Coordinate Representation, Windowing and clipping, 2 D Geometric transformations-Translation, Scaling, Shearing, Rotation & Reflection Matrix representation, Composite transformation, 2 D transformations, multiple transformation .

UNIT-III	Geometric Modeling	07Hours

Geometric Modeling: Wire frame modeling, wire frame entities, Interpolation and approximation of curves, Concept of parametric and non-parametric representation of curves, Curve fitting techniques, definitions of cubic spline, Bezier, and B-spline.

Surface modeling: Algebraic and geometric form, Parametric space of surface, Blending functions, parametrization of surface patch, Subdividing, Cylindrical surface, Ruled surface, Surface of revolutionSpherical surface, Composite surface, Bezier surface. Bspline surface, Solid Modelling:

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Definition of cell composition and spatial occupancy enumeration, Sweep representation, Constructive solid geometry, Boundary representations.

UNIT-IV	Computer aided Manufacturing	07Hours

Introduction to Computer Aided Manufacturing (CAM), Coordinate system, Working principal of CNC Lathe, Turning Centers, Milling Machine, Steps in developing CNC part program, Tool and geometric compensations, subroutine and Do loop using canned cycle. [Only theory – 2 hrs] CNC Lathe part programming (FANUC) : Linear and circular interpolation, Canned cycles for facing, threading, grooving, etc. [Theory + Program] CNC Milling part programming (FANUC): Linear and circular interpolation, Pocketing, contouring and drilling cycles. [Theory + Program]

UNIT-V	Introduction to CAE	07Hours

Finite Element Analysis: Basic concept of the finite element method, comparison of FEM with direct analytical solutions; Steps in finite element analysis of physical systems, Finite Element analysis of 1-D problems like spring, bar, truss and beam elements formulation by direct approach; development of elemental stiffness equations and their assembly, solution and its post processing.

UNIT-VI	Automation	07Hours

Automation : Introduction, Automation strategies, Types of Automation - Hard and Soft Automation, Flexible Manufacturing System – Types, Advantages, Limitations, AGVs and AS/RS [Only theory] Group Technology: Introduction, Coding Methods, Concepts of Computer Integrated Manufacturing (CIM) and Computer Aided Process Planning (CAPP), Variant & Generative methods of CAPP, advantages of CAPP. [Only theory] Robotics: RIA definition of Robot, Laws of robotics, Classification of robots, robot anatomy, Point to point and continuous path robotic systems, Joints, End Effectors, Grippers - Mechanical, Magnetic and Pneumatic, Applications. [Only theory]

Text Books:

T1. CAD/CAM Concepts and Applications / Alavala / PHI
T2. CAD/CAM Principles and Applications / P. N. Rao / Mc Graw Hill.
T3. J. D. Anderson, Computational Fluid Dynamics, McGraw Hill

Reference Books:

R1. CAD/CAM/ Groover M.P/ Pearson
R2. CAD/CAM/CIM/ Radhakrishnan and Subramanian / New Age
R3. Anderson, D.A., Tannehill, J.C., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, McGraw Hill Book Company.
R4. CAD/CAM :Theory and Practice, by Ibrahim Zeid, McGraw Hill

On-line Recourses :

NPTEL Lecture series

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Final Year B. Tech (Mechanical Engineering)

Semester -VII

[MEM4201T]: Automobile Engineering

Teaching Scheme:	Credit	Examination Scheme:
TH:03 Hours/Week	TH: 03	In Sem. Evaluation:30 Marks Mid Sem. Exam: 20 Marks End Sem. Exam: 50Marks Total:100 Marks

Course Prerequisites :

Course Objectives:

To make the student conversant with fundamentals of automobile systems.
To develop competencies in performance analysis of vehicles.
To make the student conversant with automobile safety, electrical system and vehicle maintenance. To understand the emerging trends of electric vehicles, hybrid electric vehicles and solar vehicles.

Course Outcomes:

After successful completion of the course, students will able to:

CO 1. Compare and select the proper automotive system for the vehicle.
CO 2. Understand Axles, Wheels and Tyres, Steering System
CO 3. Understand Suspension and Brake System
CO 4. Analyse the performance of the vehicle.
CO 5. To diagnose the faults of automobile vehicles.
CO 6. To apply the knowledge of EVs, HEVs and solar vehicles

Course Contents

UNIT-I	Introduction and Drive Train	07Hours

Introduction: Current scenario in Indian auto/ancillary industries, vehicle specifications and classification.
Chassis and Frames: Types of chassis layout with reference to power plant locations and drive, various types of frames.
Drive Train: Types of transmission system, necessity and selection of clutch, necessity of gear box and different types, continuous variable transmission, propeller shaft, final drive and differential.

UNIT-II	Axles, Wheels and Tyres, Steering System	07Hours

Axles: Purpose, requirement and types of front and rear axle, loads acting on rear axles.
Wheels and tyres: Wheel construction, alloy wheel, wheel balancing, type of tyres, tyre rating, tyre materials, factors affecting tyre life.
Steering system: Steering mechanism, steering geometry, steering characteristics, steering linkages and gearbox, power steering, reversibility of steering, four wheel steering, wheel alignment.

UNIT-III	Suspension and Brake System	07Hours

Suspension : Types of suspension linkages, types of suspension springs- leaf, coil, air springs, rubber suspension, shock absorbers (hydraulic and air). Brake systems: Drum, disc, mechanical, hydraulic, air brakes, power assisted brakes, hand brake, ABS, EBD.

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UNIT-IV	Vehicle Performance and Safety	07Hours
Vehicle performance: Parameters, vehicle resistances, traction and tractive effort, road performance curves (numericals), stability of vehicles. Vehicle safety: Types of active and passive safety, vehicle interior and ergonomics, NVH in automobiles.		
UNIT-V	**Electrical System**	**07Hours**
Electrical system and accessories : electrical fuel pump, speedometer, fuel, oil and temperature gauges, horn, wiper system, automotive sensors and actuators, electronic control unit/module.		
UNIT-VI	**Electric and Hybrid Electric Vehicles**	**07Hours**
Batteries: Principles and construction of lead-acid battery, characteristics of battery, rating capacity and efficiency of batteries, charging methods, introduction to lithium batteries. Introduction: Concept and environmental importance of EVs, HEVs and solar vehicles. Electric vehicles: Layout, construction and working. Hybrid electric vehicles: Types, layout, hybridization factor, plug in hybrid electric vehicles, fuel efficiency analysis. Challenges and future scope of EVs and HEVs.		

Text Books:

T1. K. Newton and W. Seeds, T.K. Garrett, "Motor Vehicle", 13thEdition, Elsevier publications.
T2. Hans Hermann Braess, Ulrich Seiffen, "Handbook of Automotive Engineering", SAE Publications.
T3. William H. Crouse., "Automotive Mechanics", Tata McGraw Hill Publishing House.
T4. Joseph Heitner, "Automotive Mechanics", C.B.S Publishers and Distributors.
T5. SAE Manuals and Standards.
T6. N. K. Giri, Automobile Mechanics
T7. P. S. Kohali, Automobile Electrical Equipment, Tata McGraw Hill Publishing House.
T8. Narang G. B. S, "Automobile Engineering", S. Chand and Company Ltd.

Reference Books:

R1. Dr. Kirpal Singh, "Automobile Engineering", Volume 1, Standard Publishers distributors.
R2. Automobile Mechanics, "Crouse/Anglin", TATA Mcgraw-Hill.
R3. R. B. Gupta, Automobile Engineering, Satya Prakashan
R4. Chris Mi, M .Abul Masrur, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, ,Willey.
R5. Electric and Hybrid Vehicles, Tom Denton, Routledge.
R6. Hybrid Electric Vehicle Technology, Automotive Research and Design, American Technical.
R7. Husain, Iqbal, Electric and hybrid vehicles, 2 edition, CRC Press.
R8. Ron Hodkinson and John Fenton, Butterworth-Heinemann.Lightweight Electric/ Hybrid Vehicle Design,
R9. Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Standards media.

On-line Recourses :

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Final Year B. Tech (Mechanical Engineering)

Semester -VII

[MEM4201L]: Automobile Engineering Lab

Teaching Scheme:	Credit	Examination Scheme:
LAB:02 Hours/Week	LAB: 01	ISCE: 30 Marks ESE: 20 Marks Total: 50 Marks

Course Prerequisites :

Course Objectives:

To make the student conversant with fundamentals of automobile systems.
To develop competencies in performance analysis of vehicles.
To make the student conversant with automobile safety, electrical system and vehicle maintenance. To understand the emerging trends of electric vehicles, hybrid electric vehicles and solar vehicles.

Course Outcomes:

After successful completion of the course, students will able to:
CO 1: Compare and select the proper automotive system for the vehicle.
CO 2: Understand Axles, Wheels and Tyres, Steering System
CO 3: Understand Suspension and Brake System
CO 4: Analyse the performance of the vehicle.
CO 5: To diagnose the faults of automobile vehicles.
CO 6: To apply the knowledge of EVs, HEVs and solar vehicles

Lab Contents

List of Laboratory Experiments (Any 10)

1	Study of different Automobile Engine System
2	Dismantling and assembling of any clutch
3	Dismantling and assembling of any gear box
4	Dismantling and assembling of differtial gear box
5	Dismantling and assembling of steering gear box
6	Dismantling and assembling of any braking system
7	Performance of petrol engine
8	Performance of diesel engine
9	Performance of electric vehicle
10	Study of chassis dynamometer
11	Study of different Automotive research Institutes

Text Books:

T1. K. Newton and W. Seeds, T.K. Garrett, "Motor Vehicle", 13thEdition, Elsevier publications.
T2. Hans Hermann Braess, Ulrich Seiffen, "Handbook of Automotive Engineering", SAE Publications.
T3. William H. Crouse., "Automotive Mechanics", Tata McGraw Hill Publishing House.

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T4. Joseph Heitner, “Automotive Mechanics”, C.B.S Publishers and Distributors.
T5. SAE Manuals and Standards.
T6. N. K. Giri, Automobile Mechanics
T7. P. S. Kohali, Automobile Electrical Equipment, Tata McGraw Hill Publishing House.
T8. Narang G. B. S, “Automobile Engineering”, S. Chand and Company Ltd.

Reference Books:

R1. Dr. Kirpal Singh, “Automobile Engineering”, Volume 1, Standard Publishers distributors.
R2. Automobile Mechanics, “Crouse/Anglin”, TATA Mcgraw-Hill.
R3. R. B. Gupta, Automobile Engineering, Satya Prakashan
R4. Chris Mi, M .Abul Masrur, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, ,Willey.
R5. Electric and Hybrid Vehicles, Tom Denton, Routledge.
R6. Hybrid Electric Vehicle Technology, Automotive Research and Design, American Technical.
R7. Husain, Iqbal, Electric and hybrid vehicles, 2 edition, CRC Press.
R8. Ron Hodkinson and John Fenton, Butterworth-Heinemann.Lightweight Electric/ Hybrid Vehicle Design,
R9. Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Standards media.

On-line Recourses :

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Department of Electrical Engineering
Multidisciplinary Minor (offered to other Department)
Academic Year -2024-2025
Syllabus Structure

Course Code	Course Title	Teaching Plan				Credit	Examination Scheme			Total Marks
		L	T	P	Hr	C	ISE	MSE	ESE	
Second Year (Sem - IV)										
EE2201T	Electrical Motor	3	-	-	3	**3**	20	30	50	**100**
Third Year (Sem - V)										
EE3201T	Renewable Energy Sources	3	-	-	3	**3**	20	30	30	**50**
EE3201L	Renewable Energy Sources Lab	-	-	2	2	**1**	ISCE: 30		50	**100**
Third Year (Sem - VI)										
EE3202T	Electric and Hybrid Vehicle Technology	3	-	-	3	**3**	20	30	20	**50**
Final Year (Sem-VII)										
EE4201T	Energy Audit and Management	3	-	-	3	**3**	20	30	50	**100**
EE3203L	Energy Audit and Management Lab	-	-	2	2	**1**	ISCE: 30		20	**50**
Total		**12**		**4**	**16**	**14**			**400**	**450**

Abbreviations: L – Lecture, T – Tutorial, P – Practical, Hr – Hours, C – Credits, ISE – In Semester Evaluation, MSE – Mid Semester Evaluation, ESE – End Semester Evaluation.

Notes:

1. For Theory courses: There shall be MSE, ISE and ESE. The ESE is a separate head of passing.
2. For Lab courses: There shall be continuous assessment (ISCE consists of ISE and MSE). The ESE is a separate head of passing.

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Department of Electrical Engineering

S. Y.B. Tech (Electrical Engineering)

Academic Year: 2024-2025 Semester-IV

[EEM2201T]: Electrical Motor

Teaching Scheme	Credit:03	Examination Scheme
Teaching Scheme: TH:03 Hours/Week	TH: 03	Theory Marks – 100Marks
		InSem. Evaluation :20Marks MidSem. Exam :30Marks EndSem. Exam :50Marks Total :100Marks

Course Prerequisites : Basic Electrical Engineering

Course Objective:

To describe working principles and analyze performance of DC Motor & Induction Motor. Also to study various types of starters of DC and AC Motors along with to identify selection of machine for specific application. Also to make students to understand concept of power electronics &Arduino.

Course Outcome:

After successful completion of the course, students will able to:

CO1: Develop the capability to identify, select suitable DC motor and its speed control method for given industrial application.

CO2: Explain various speed control methods for Induction Motor

CO3: Identify various types of electrical machines

CO4: Analyze the performance of power electronic converters

CO5:Apply the knowledge of Arduino for various Engineering applications

Course Contents

UNIT-I	D. C. Motors	07 Hours

Construction, Working, Types, Back EMF, Speed equation, Torque equation, Speed torque characteristics, Power losses in D.C. Motors. Need of starter, 3 point starter, 4 point starter, face plate controller. Speed control of D.C. Shunt and series motor (numerical treatment)

UNIT-II	Three Phase Induction Motor	07 Hours

Construction, Working, Types, Speed equation, Torque equation, Starting torque, Concept of full load torque, Torque speed characteristics, Power stages in motor (Numerical treatment), Comparison between DC and AC Motor.

UNIT-III	Three Phase Induction Motor Control	07 Hours

Need of starter, Star delta starter, DOL starter, Autotransformer starter, Rotor resistance starter. Speed control methods- Pole changing, Voltage control, VFD (V/f) control,
, Rotor resistance speed control. Reversal of rotation

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UNIT-IV	Special Purpose Motor	07 Hours
Features, construction, Working, characteristics, Applications of AC servo motor, DC servo motor, Stepper motor (VR type and PM type). Introduction to BLDC motor and linear induction motor.		
UNIT-V	**Electric Motor Control With Converters**	**07Hours**
Construction, Static and dynamic Characteristics of Diode, Half Wave Uncontrolled Converter with R & RL load, Full Wave Uncontrolled Converter, Half Wave Controlled Converter with R & RL load, Full Wave Controlled Converter, Derivation of Average & RMS Output voltage		
UNIT-VI	**Electric Motor Interfacing With Arduino**	**07 Hours**
Introduction to microcontroller and microprocessors, ATmega 328P- features, architecture, port structure, Concept of GPIO in ATmega 328P based Arduino board, digital input and output,timers, interfacing with LED, LCD and keypad, serial communication using Arduino IDE.		

Text Books:

T1. Ashfaq Husain, "Electrical Machines", Dhanpat Rai& Sons.
T2. S. K. Bhattacharya, "Electrical Machine", Tata McGraw Hill publishing Co. Ltd, 2nd Edition.
T3. Nagrath& Kothari, "Electrical Machines", Tata McGraw.
T4. R. K. Rajput, "Electrical Machines", Laxmi Publications 2002.
T5. M. H. Rashid –"Power Electronics" 2nd Edition, Pearson publication.
T6. Dr. P.S. Bimbhra, "Power Electronics", Third Edition, Khanna Publication.
T7. Ajay Deshmukh, "Microcontrollers Theory and Applications", TATA McGraw Hill.
T8. Steven F Barret& Morgan, "Arduino microcontroller processing for everyone", Claypool Publisher.
T9. Warwick Smith, "C programming with Ardino", Elektor Publication.

Reference Books:

R1.S. L. Uppal, "Electrical Power", DBS Publication.
R2.U. A. Bakshi, "Electrical Technology", Technical Publication Pune, 4th Edition, 2009.
R3.A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, "Electrical Machines", Tata McGraw Hill Publication Ltd. Fifth Edition.
R4.M. D. Singh and K. B. Khandchandani, Power Electronics, Tata McGraw Hill.
R5.Vedam Subramanyam, "Power Electronics", New Age International, New Delhi.

On-line Recourses :

https://nptel.ac.in/courses/108/108/108108076/

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T.Y B. Tech. (Electrical Engineering)
Academic Year: 2024-2025 Semester - V
[EEM3201T]: Renewable Energy sources

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	TH: 03	In Sem. Evaluation: 20 Marks Mid Sem. Exam : 30 Marks End Sem. Exam : 50 Marks Total : 100 Marks

Course Prerequisites: Introduction of Electrical supply system, Introduction to power system, Different types of conventional generation system.

Course Objective:

- To develop fundamental understanding about Solar Thermal and Solar Photovoltaic systems.
- conceptualize and design photovoltaic system
- To provide knowledge about development of Wind Power plant and various operational as well as performance parameter/characteristics.
- To describe different Storage systems, Integration and Economics of Renewable Energy System

Course Outcome:

After successful completion of the course, students will able to:

CO1: Describe various renewable energy sources such as Solar Photovoltaic, Wind, Solar thermal.

CO2: Interpret the economics of renewable energy systems.

CO3: conceptualize and design photovoltaic system.

CO4: Acquire knowledge about different types of solar and wind energy conversion technology and its grid interface.

Course Contents

UNIT-I	Global and National Energy Scenario	06 Hours

Global and National Energy Scenario: Over view of conventional & renewable energy sources, need, potential &development of renewable energy sources, types of renewable energy systems, Future of Energy Use, Global and Indian Energy scenario, Energy for sustainable development, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy-concept of Hybrid systems.

UNIT-II	Solar Energy	06 Hours

Basic Concepts: Introduction, The Sun as Source of Energy, The Earth, Sun, Extraterrestrial and Terrestrial Radiations, Spectral Power Distribution of Solar Radiation, Depletion of Solar Radiation. Measurement of Solar Radiation, Solar Radiation on Inclined Plane Surface.

Solar Thermal Systems: Applications of Solar energy like (Collectors, Solar Water Heater, Solar Passive Space Heating and Cooling Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers)

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UNIT-III	Solar Photovoltaic Systems	06 Hours
Solar Photovoltaic Systems: Introduction, Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell Technologies, Solar Cell, Module, and Array Construction, Effect of temperature on pv cell, fill factor, series and parallel connection of PV cell Maximizing the Solar PV. Maximum Power Point Tracker. Balance of System Components, Solar PV Systems, Solar PV Applications, Sizing of PV system without battery, PV system design with battery.		
UNIT-IV	**Wind Energy**	**06 Hours**
Wind Energy: Introduction, Basic Principles of Wind Energy Conversion, Wind Energy Scenario – World and India. The Nature of the Wind, The Power in the Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection Considerations, Environment and Economics Environmental benefits and problems of wind energy, Wind in the world, wind energy scenario in India.		
UNIT-V	**Wind Energy Conversion (WEC) System**	**06 Hours**
Classification of WEC systems, wind system components – tower, turbine blades, yaw control and speed control, Analysis of Aerodynamic Forces Acting on the Blade, Performance of Wind- machines, Generating Systems, Energy Storage, Applications of Wind Energy, Environmental Aspects.		
UNIT-VI	**Integrated Energy Systems**	**06 Hours**
Introduction, Integrated Smart infrastructure, Integrated Energy system,Various Integrated energy schemes, their cost benefit analysis, Simple payback, Internal Rate of Return (IRR), time value, Net present value (NPV), Life cycle costing, Effect of fuel cost Escalation.		

Text Books:

T1: Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, TMH, New Delhi, 3rd Edition.

T2: Renewable Energy Resources, John Twidell and Tony Weir, Taylor and Francis -second edition, 2013.

T3: Non-Conventional Energy Sources /G.D. Rai, Khanna Publishers

T4: Mukund R. Patel, "Wind and Power Solar System", CRC Press.

T5: Tony Burton, Nick Jenkins, David Sharpe, "Wind Energy Hand Book-Second Edition", John Wiley & Sons, Ltd., Publication.

Reference Books:

R1: Renewable Energy- Edited by Godfrey Boyle-oxford university, press, 3rd edition, 2013.

R2: Handbook of renewable technology Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.

R3: Renewable Energy Technologies /Ramesh & Kumar /Narosa

R4: Renewable energy technologies – A practical guide for beginners – Chetong Singh Solanki, PHI.

R5: Non-Conventional Energy source –B.H. Khan- TMH-2nd edition.

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T.Y B.Tech. (Electrical Engineering)
Academic Year: 2024-2025 Semester - V
[EEM3201L]: Renewable Energy Sources Lab

Teaching Scheme: Lab: 02 Hours/Week	Credit Lab:01	**Examination Scheme**
		Lab Marks – **50 Marks**
		In Sem. Evaluation: **20** Marks Mid Sem. Exam : **10** Marks End Sem. Exam : **20** Marks

Course Prerequisites: Introduction of Electrical supply system, Introduction to power system, Different types of conventional generation system.

Course Objective:

- To develop fundamental understanding about Solar Thermal and Solar Photovoltaic systems.
- conceptualize and design photovoltaic system
- To provide knowledge about development of Wind Power plant and various operational as well as performance parameter/characteristics.
- To describe different Storage systems, Integration and Economics of Renewable Energy System

Course Outcome:

After successful completion of the course, students will able to:

CO1: Describe various renewable energy sources such as Solar Photovoltaic, Wind, Solar thermal.

CO2: Interpret the economics of renewable energy systems.

CO3: conceptualize and design photovoltaic system.

CO4: Acquire knowledge about different types of solar and wind energy conversion technology and its grid interface.

(Any Eight experiments)

1	To demonstrate the I-V and P-V characteristics of PV module with varying radiation and temperature level of series and parallel combination of PV modules.
2	To demonstrate the effect of variation in tilt angle and shading on PV module.
3	To demonstrate the working of diode as bypass diode and blocking diode.
4	Workout power flow calculations of stand-alone PV system with combined DC and AC load with battery.
5	To draw the charging and discharging characteristics of battery.
6	Evaluate the efficiency of charge controller.
7	Find out the start up speed and cut -in speed of wind turbine and also find Tip Speed ratio (TSR) at different wind speeds.
8	Evaluate the coefficient of performance of wind turbine.
9	Draw the Turbine Power versus Wind Speed curve.

10	Draw the curve between TSR and coefficient of power.
11	Draw the power curve of turbine with respect to the rotational speed of rotor at fix wind Speeds.
12	Demonstrate the power analysis at different branches of wind turbine energy system (at high Frequency) with AC load and DC load.

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T. Y. B. Tech (Electrical Engineering)

Semester –VI MDM

[EEM3202T]]: Electric and Hybrid Vehicle Technology

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	TH: 03	In Sem. Evaluation : 20 Marks Mid Sem. Exam : 30 Marks End Sem. Exam : 50 Marks Total : 100 Marks

Course Prerequisites: Basic Electrical and Electronics Engineering, Electrical Machines, Power Electronics

Course Objective:

- To make students understand the need and importance of Electric, Hybrid Electric Vehicles and Fuel cell vehicle.
- To differentiate and analyze the various energy storage devices and battery charging and management systems.
- To impart knowledge about architecture and performance of Electric and Hybrid Vehicles.
- To classify the different drives and controls used in electric vehicles.

Course Outcome:

After successful completion of the course, students will able to:

CO1: Illustrate EVs and EV subsystems and Identify forces acting on EVs

CO2: Interpret performance and selection of energy storage systems in EVs **CO3:** Analyze battery management system.

CO4: Infer history and basics of HEV and basic architecture of train drives in HEV

Course Contents

UNIT-I	Introduction to Electric Vehicle	07 Hours

Overview & History of electric vehicles, social and environmental importance of electric vehicles, Vehicle motion and the dynamic equations for the vehicle. EV Subsystem, forces acting on when a vehicle move, aerodynamic drag, rolling resistance and uphill resistance, power and torque to accelerate & putting it all together, concept of drive cycle

UNIT-II	Energy Storage System	07 Hours

Basics – types, parameters – capacity, discharge rate, state of charge, state of discharge, depth of discharge, Technical characteristics, battery pack design, properties of batteries, introduction to energy, storage requirements in hybrid and electric vehicles , battery pack development.

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UNIT-III	Battery Charging & Management systems	07 Hours
Introduction, charging algorithm, balancing method for battery pack charging. Battery management system representation: - battery module, measurement unit block, battery equalization balancing unit, MCU estimation unit, display unit, fault warning block, Thermal monitoring of battery unit.		
UNIT-IV	**Introduction to Hybrid Electric Vehicle**	**07 Hours**
Introduction to Hybrid Electric Vehicles: Social and environmental importance of hybrid electric vehicles, Basic architecture of hybrid drive train and analysis series drive train, Analysis of parallel drive train. Series, parallel and complex drive trains and power flow in each case. Braking Fundamentals and regenerative braking in HEVs.		
UNIT-V	**Power Electronics in EV**	**07 Hours**
Introduction to power diode & power electronics switches, concept about AC-DC conversion, DC-AC conversion, DC-DC conversion, Basic DC-DC Converters for EV.		
UNIT-VI	**Motor and Control in EV**	**07 Hours**
Electrical Design, EV Motors & Controllers – Understanding Flow,Power & efficiency, Torque production, Speed and back emf. Introduction to CAN Protocol.		

Text Books:

T1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.
T2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 20 3
T3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Reference Books:

R1. Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles by John G. Hayes and A. Goodarzi, Wiley Publication.
R2. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000 .http://nptel.ac.in/courses/108103009/
R3. Ehsani, M.; Gao, Y.; Emadi, A. Modern electric, hybrid electric, and fuel cell vehicles fundamentals, theory and design. 2nd Edition.

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Final Year B. Tech (Electrical Engineering)

Academic Year: 2025-26 Semester-VII

[EEM4201T]: Energy Audit and Management

Teaching Scheme:	Credit	Examination Scheme Theory	
Theory :03Hours/Week	Theory: 03	In Sem. Evaluation:	20Marks
		Mid Sem. Exam :	30Marks
		End Sem. Exam :	50Marks
		Total :	100Marks

Course Pre-requisites: Energy Conversion, Energy Measurement, Electrical Utilization, Thermal Utililization.

Course Objective:

- To Study the importance of energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical installations to facilitate the energy management.
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities

Course Outcome:

After successful completion of the course, students will able to:

CO1: Understanding energy scenario, energy sources and their utilization.

CO2: Identify the principles and methodologies of energy auditing and financial analysis.

CO3: Evaluating the performance electrical and thermal utilities and list the energy saving opportunities.

CO4: Analysis of Energy Performance Assessment and Energy conservation in Buildings.

Course Contents

UNIT-I	Energy Scenario	06Hours

Indian energy scenario, different forms of energy, principles of renewable energy, renewable energy availability in India, renewable energy sources and features. Commercial and Non-commercial energy, energy security, energy conservation and its importance.

UNIT-II	Energy Auditing	06Hours

Definition and objectives of energy management, Energy audit – types and methodology, Need for energy audit, Energy auditing methodology, Understanding energy costs, Benchmarking, Energy performance, Maximizing system efficiency, Instruments and metering for Energy Audit.

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UNIT-III	Financial Analysis and Management	07Hours
Investment-need, appraisal and criteria, financial analysis techniques-simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of ESCOs, Defining monitoring & targeting, elements of monitoring & targeting		
UNIT-IV	**Energy Efficiency in Electrical Utilities**	**08Hours**
Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors, energy conservation opportunities in Fans, Blower, Pumps, Lighting System		
UNIT-V	**Energy Efficiency in Thermal Utilities**	**08Hours**
Review of different thermal loads, Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings, Energy conservation opportunities in Boiler and Furnaces. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities		
UNIT-VI	**Energy Performance Assessment and Conservation in Buildings**	**07Hours**
On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method. Energy Conservation Building Codes(ECBC): Green Building, Leadership in Energy and Environmental Design(LEED) rating, Application of Non-Conventional and Renewable Energy Sources		

Text Books:

[T1] General Aspects of Energy Management & Energy Audit, http://www.em-ea.org/gbook11.asp, National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India

[T2] Energy Performance Assessment for Equipment and Utility systems, http://www.em-ea.org/ gbook14.asp, National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India.

[T3] Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2 nd edition, 1995.

Reference Books:

[R1] Handbook of Electrical Installation Practice, Geoffrey Stokes, Blackwell Science.
[R2] Designing with light: Lighting Handbook, By Anil Valia, Lighting System
[R3] Energy Management Handbook, By W.C. Turner, John Wiley and Sons.
[R4] Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
[R5] Energy Management Principles, C.B. Smith, Pergamon Press.
[R6] Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press.
[R7] Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press

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Final Year B. Tech (Electrical Engineering)

Academic Year: 2025-26 Semester -VII

[EEM4201L]: Energy Audit and Management- Laboratory

Teaching Scheme:	Credit	Examination Scheme:
LAB:02Hours/Week	LAB:01	ISCE: 30 Marks ESE: 20 marks Total: 50 Marks

Course Prerequisites: Energy Conversion, Energy Measurement, Electrical Utilization, Thermal Utilization.

Course Objective:

- To Study the importance of energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical installations to facilitate the energy management.
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities

Course Outcome:

After successful completion of the course, students will be able to:

CO1: Understanding fundamentals of electricity bills and utilization of electrical energy.

CO2: Assess energy generation and performance of domestic/commercial equipment's.

CO3: Conduct preliminary audit and find energy saving opportunities.

CO4: Study energy standards and modern tools of energy management

Laboratory Contents

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a hands-on resource and reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ prefaceetc),Autonomoussyllabus,conduction&Assessmentguidelines,topicsunderconsideration-concept, Objectives, outcomes, set of typical applications/assignments/guidelines, and references.

Guidelines for Assessment

ISCE: 30 Marks

ESE: 20 marks

- Total Marks: 50M
- It is a continuous assessment where performance is judged on the basis of attendance, journal write-ups, practical and oral at the end of semester.

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List of Laboratory Assignments/Experiments (minimum 8 to be covered)	
1	Analysis and interpretation of Electricity Bills.
2	Adequacy assessment of Illumination systems by using Lux Meter.
3	Use of power analyzer for measurement of electrical parameters useful for energy audit
4	Assessment and calculations of energy generated by Solar PV or other renewable sources / Diesel generator available in college campus.
5	Assessment of performance of fans and blowers by using Anemometer.
6	Execute Preliminary Energy Audit for (Any One) a) Laboratory b) Educational Institute c) Commercial Establishment d) Small scale industry e) Residential Building f) Agricultural Equipment's g) Municipal Corporations.
7	Calculation of energy savings for following (Minimum one)a) Illumination b) Air conditioning system c) Pumping Systems d) DG Sets e) UPS and Inverter Systems f) Lifts and elevators
8	Study of standards and labeling.
9	Study of energy management tools.
10	Study of energy audit success stories (any one) a) Paper and Pulp Industry b) Sugar Industry c) Steel Industry d) Commercial Establishment e) Electrical Generation Plant.

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Department of Information Technology

Structure and Syllabi
for
Multidisciplinary Minor (offered to other Departments)

w. e. f. Academic Year 2024-2025
(2023 Pattern)

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Department of Information Technology

Multidisciplinary Minor (offered to other Departments)

Structure (Effective from 2024-25)

(2023 Pattern)

Course Code	Course	Teaching Scheme				Credit	Examination Scheme			Total Marks
		L	T	P	Hr	C	ISE	MSE	ESE	
S. Y. Sem IV										
ITM2201T	Data Structures Essentials	3	-	-	3	3	20	30	50	100
T. Y. Sem V										
ITM3201T	Fundamentals of Operating Systems	3	-	-	3	3	20	30	50	100
ITM3201L	Fundamentals of Operating Systems Laboratory	-	-	2	2	1	ISCE: 30		20	50
T. Y. Sem VI										
ITM3202T	Computer Network	3	-	-	3	3	20	30	50	100
B.Tech. Sem VII										
ITM4201T	Digital Forensic and Cyber Laws	3	-	-	3	3	20	30	50	100
ITM4201L	Digital Forensic and Cyber Laws Laboratory	-	-	2	2	1	ISCE: 30		20	50
Total		**12**	**-**	**4**	**16**	**14**			**240**	**500**

Abbreviations:
L – Lecture, T – Tutorial, P – Practical, Hr – Hours, C – Credits, TuT – Tutorial, ISE – In Semester Evaluation, MSE – Mid Semester Evaluation, ESE – End Semester Evaluation

Notes:
For Theory courses: There shall be MSE, ISE and ESE. The ESE is a separate head of passing.
For Lab courses: There shall be continuous assessment (ISCE consists of ISE and MSE). The ESE is a separate head of passing.
For Tutorial: Assessment shall be ISE of the respective course

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Department of Information Technology

Semester -IV

[ITM2201T]: Data Structure Essentials(2023 Pattern)

Teaching Scheme:	**Credits:**	**Examination Scheme:**
TH: 03 Hours/Week	TH:03	In Sem. Evaluation : 20 Marks Mid Sem. Exam : 30 Marks End Sem. Exam : 50 Marks

Course Prerequisites: Programming Skills

Course Objectives:

- To acquaint with the knowledge of data structures and program design.
- To learn the object-oriented programming concepts.
- To understand array data structures and its operations
- To study different data searching and sorting methods
- To understand stack and queue abstract data types
- To study nonlinear data structure linked list and tree with their types

Course Outcomes: After successful completion of the course, students will able to-

CO1: Discuss different linear and nonlinear abstract data structures.
CO2: Implement different linear data structure for solving various problem.
CO3: Demonstrate different searching and sorting techniques
CO4: Apply linear and non linear data structures for solving problems.

Course Contents

UNIT-I	**Introduction to Data Structures**	**07 Hours**

Algorithms and Flowcharts, Basic Analysis on Algorithm, Complexity of Algorithm, Introduction and Definition of Data Structure, Classification of Data, Arrays, Various types of Data Structure, Static and Dynamic Memory Allocation, Function, Recursion.

UNIT-II	**Introduction to Object Oriented Programming**	**07 Hours**

Inheritance basics, base and derived classes, inheritance types, base class access control, Function Over Loading, Operator Overloading, Generic Programming- Function and class templates, runtime polymorphism using virtual functions, abstract classes, streams I/O.

UNIT-III	**Array**	**06 Hours**

Overview of Array, Array as an abstract data type, Operations on array, Merging of Two Arrays, storage representation and their address calculation, Row major and column major, Multidimensional Arrays:

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Two-dimensional arrays, n-dimensional arrays, single variable polynomial and sparse matrix representation using array.		
UNIT-IV	**Searching and sorting Techniques**	**07 Hours**
Searching: Search Techniques- Sequential search/Linear Search, Variant of Sequential Search-Sentinel Search, Binary search **Sorting:** General Sort Concepts-Sort Order, Stability, Efficiency, and Number of Passes, Comparison Based Sorting Methods-Bubble Sort, Insertion Sort, Selection Sort, Quick Sort, Shell Sort, Non-comparison Based Sorting Methods-Radix Sort, Counting Sort, and Bucket Sort, Comparison of All Sorting Methods and their complexities.		
UNIT-V	**Stack & Queue**	**07 Hours**
Introduction to Stack, Definition, Stack Implementation, Operations of Stack, Applications of Stack and Multiple Stacks. Implementation of Multiple Stack Queues, **Introduction to Queue,** Definition, Queue Implementation, Operations of Queue, Circular Queue, De-queue and Priority Queue		
UNIT-VI	**Linked Lists and Trees**	**08 Hours**
Introduction Representation and Operations of Linked Lists, Singly Linked List, Doubly Linked List, Circular Linked List, And Circular Doubly Linked List. **Trees Introduction** to Tree, Tree Terminology Binary Tree, Binary Search Tree, Strictly Binary Tree, Complete Binary Tree, Tree Traversal, Threaded Binary Tree, AVL Tree B Tree, B+ Tree.		

Text Books:

T1. Horowitz and Sahani, "Fundamentals of Data Structures in C++ " University Press, ISBN: 10:0716782928, ISBN: 13: 9780716782926.

T2. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "data Structures and Algorithms in Python", Wiley Publication, ISBN: 978-1-118-29027-9

Reference Books:

R1. An Introduction to Data Structures with Applications. by Jean-Paul Tremblay & Paul G. Sorenson Publisher-Tata McGraw Hill.

R2. Data Structures using C & C++ -By Ten Baum Publisher – Prenctice-Hall International.

R3. Fundamentals of Data Structures in C++-By SartajSahani.

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Department of Information Technology

Semester -V

[ITM3201T]: Fundamentals of Operating Systems (2023 Pattern)

Teaching Scheme:	Credits:	Examination Scheme:
TH : 03 Hours/Week	TH: 03	In Sem. Evaluation: 20 Marks Mid Sem. Exam : 30 Marks End Sem. Exam : 50 Marks

Course Prerequisites:

CS1203T Fundamentals of Computer Programming

Course Objectives:

1. To introduce basic concepts of os and function of Operating System.
2. To understand the basic concept of process, scheduling and thread management.
3. To learn the concept of concurrency control with deadlock.
4. To understand various Memory Management techniques.
5. To understand the concept of I/O and File management.
6. To learn operating system role in muti disciplinary applications

Course Outcomes: After successful completion of the course, students will able to-

CO1: Describe the basic concepts and functions of Operating Systems.

CO2: Demonstrate operating system role in multidisciplinary applications.

CO3: Apply and analyze different process and memory management techniques of operating system.

CO4: Evaluate synchronization and concurrency techniques used in process management.

Course Contents

UNIT-I	Introduction to Operating system	07 Hours

Introduction to OS, General types of operating systems, Operating system components, OS Services, Linux Command Shell , Basic Linux usage with different types of commands.

UNIT-II	Process Management and Scheduling	07 Hours

Process: Concept of a Process, Process States, Process Description, Process Control (Process creation, waiting for the process/processes, Loading programs into processes and Process Termination), Execution of the Operating System.

Scheduling: Types of Scheduling, Scheduling Algorithms, and Thread Scheduling

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UNIT-III	Process Synchronization and Deadlock	07 Hours
Process Synchronization and Mutual Exclusion: Principles of Concurrency, Requirements for Mutual Exclusion, Operating System Support (Semaphores and Mutex), **Deadlock:** Principles of Deadlock, Strategies to deal with deadlock: The Bankers Algorithm, Deadlock Prevention, Deadlock Avoidance, **Case Study :** Dining Philosopher Problem		
UNIT-IV	**Memory Management**	**07 Hours**
Memory Management: Memory Management Requirements, Memory Partitioning: Fixed Partitioning, Dynamic Partitioning, Relocation, Paging, Segmentation, Virtual Memory Demand Paging.		
UNIT-V	**File Management and Storage Structures**	**07 Hours**
File Organization, Concept of files and directories, System calls for file systems, Free space management, Disk layout, Efficiency and performance, Disk Structure, Disk Scheduling.		
UNIT-VI	**Case Studies**	**07 Hours**
Real time operating system , Resource Management, operating system support for CAD/CAM Software, Structural Analysis, Geotechnical Engineering		

Text Books:

T1. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, ISBN-10: 0-13- 380591-3

T2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, WILEY, ISBN 978-1-118-06333-0, 9th Edition

T3. Andrew S. Tanenbaum & Herbert Bos, Modern Operating System, Pearson, ISBN-13: 9780133592221, 4th Edition

Reference Books:

R1. Milan Milenkovic; Operating Systems; Tata McGraw Hill; Second Edition. ISBN: 0-07-044700-4

R2. Maurice J. Bach; The Design of the Unix Operating System; Prentice Hall of India; ISBN: 978-81-203-0516-8

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Department of Information Technology
Semester -V
[ITM3201L]: Fundamentals of Operating Systems Laboratory (2023 Pattern)

Teaching Scheme:	Credits:	Examination Scheme:
LAB: 02 Hours/Week	LAB: 01	ISCE: 30 Marks ESE:20 Marks

Course Prerequisites:

CS1203L Computer Programming Laboratory

Laboratory Objective:

- To understand basics of operating system
- To learn /simulate different concepts of operating system function.

Laboratory Outcomes:

LO1: Demonstrate the use of built-in commands of Linux operating system.
LO2: Demonstrate different process related system calls.
LO3: Analyze /Simulate process scheduling algorithms as well as disk scheduling.
LO4: Design and develop any application using multithreading.
LO5: Simulate memory management techniques and bankers algorithm for deadlock avoidance.

Lab Contents

Guidelines for Assessment

Continuous assessment of laboratory work is to be done based on overall performance and lab practical's /assignments performance of student. Each lab practical/assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness. Laboratory evaluation includes In-semester Continuous Evaluation and End Semester Evaluation.

List of Laboratory Assignments/Experiments

1	**Study Basic utilities /built in commands of Linux OS** (A) : To study of Basic UNIX Commands 1. Process Related Commands 2. File Related commands 3. Use of Basic utilities like date, echo, lp etc 4. searching patterns using Sed, Grep (B) To study the Unix editors vi, ed etc

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2	**Shell Programming** Write a **shell** program to: (A) Design a basic calculator (B) Use of different loops
3	**Process Related system Calls** 1. To write C Programs using the following system calls of UNIX operating system fork, getpid, getppid, exit, wait.
4	**Process Scheduling** Simulate the following CPU scheduling algorithms. a) FCFS b) SJF c) Round Robin.
5.	**Threads** Implement threads for basic matrix operations.
6.	**Deadlock** Simulate Bankers Algorithm for Dead Lock Avoidance
7.	**Main Memory Management** Write a C program to simulate the following contiguous memory allocation Techniques a) Worst fit b) Best fit c) First fit.
8.	Simulation of Disk Scheduling 1. FCFS 2. SSTF 3. SCAN

Text Books:

T1. Unix & Shell **Programming**, Sumitabha Das,Tata McGraw Hill Education
T2. Stalling William; "Operating Systems"; 6th Edition,Pearson Education

Reference Books:

R1. Silberschatz A., Galvin P., Gagne G.;"Operating System Concepts" ; 9th Edition; John Wiley and Sons;
R2. Yashavant Kanetkar; "Unix Shell Programming"; 2nd Edition, BPB Publications

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Department of Information Technology
Semester -VII
[ITM3202T]: Computer Network(2023 Pattern)

Teaching Scheme:	**Credits:**	**Examination Scheme:**
TH : 03 Hours/Week	TH : 03	In Sem. Evaluation: 20 Marks Mid Sem. Exam : 30 Marks End Sem. Exam : 50 Marks

Course Prerequisites: Basic Electronics Engineering

Course Objectives:
- To understand the concept of Data communication and digital data transmission.
- To familiarize students with basic concepts and types of networks.
- To describe ISO/OSI model and TCP/IP model
- To demonstrate data link, network layer of ISO/OSI Model.
- To demonstrate transport and application layer ISO/OSI Model.
- To describe emerging trends in Networking.

Course Outcomes: After successful completion of the course, students will able to-

CO1: Explain network fundamentals, classifications, layers, and transmission media.

CO2: Apply the mechanism of error control and IP addressing with routing in data link layer and network layer.

CO3: Analyse transport layer, application layer protocols along with control and security mechanisms.

CO4: Evaluate emerging networking trends, technologies, and applications.

Course Contents

UNIT-I	**Introduction to Computer Networks**	**07 Hours**

Introduction: Computer networks and distributed systems, Classifications of computer networks, basic devices used for networking, Preliminaries of layered network structures. Data communication Components: Representation of data and its flow, Various connection topology, Protocols and Standards, OSI model, Transmission Media.

UNIT-II	**Data Link Layer and MAC Protocols**	**07 Hours**

Error Detection and Correction- Parity Bits, Checksum, CRC (Cyclic Redundancy Check), Data Link Layer Protocols- Framing, Flow Control, Error Control, HDLC (High-Level Data Link Control), PPP (Point-to-Point Protocol), Medium Access Control (MAC), Controlled Access Protocols (Token Passing, Polling)

UNIT-III	**Network Layer and Routing Algorithms**	**07 Hours**

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IP Addressing and Subnetting- IPv4 vs. IPv6 addressing, Subnetting and Supernetting, CIDR (Classless Inter-Domain Routing), Routing and Forwarding- Static vs. Dynamic Routing, Routing Algorithms: Distance Vector, Link-State, Path-Vector, Routing Protocols: RIP, OSPF, BGP, Internetworking and Address Resolution- ARP (Address Resolution Protocol).

UNIT-IV	Transport Layer and Congestion Control	07 Hours

Transport Layer Protocols- TCP (Transmission Control Protocol), UDP (User Datagram Protocol), TCP Connection Establishment (Three-Way Handshake), Flow Control (Sliding Window), Error Control,

Congestion Control and Avoidance- TCP Congestion Control Mechanisms (Slow Start, Congestion Avoidance), Network Performance Issues (Latency, Bandwidth, Jitter), Quality of Service

UNIT-V	Application Layer and Network Security	07 Hours

Application Layer Protocols- DNS (Domain Name System), HTTP/HTTPS, FTP, SMTP, POP3/IMAP, Client-Server Model, P2P (Peer-to-Peer) Networks, Introduction to Network Security- Threats in Networking: Viruses, Worms, Malware, DoS (Denial of Service) Attacks, Network Security Protocols: IPsec, VPNs, Firewalls.

UNIT-VI	Emerging Trends in Networking	07 Hours

Software-Defined Networking (SDN) - Concepts and Architecture of SDN, OpenFlow Protocol, Network Virtualization, Virtual LANs (VLANs),Cloud Networking,
Cloud Infrastructure and Networking, Overview of 5G Network Architecture and Use Cases.

Text Books:

T1. Behrouz A. Forouzan, Data Communication and Networking, McGraw Hill Education, ISBN:78- 125-906475-3, 5th Edition

T2. Andrew S Tanenbaum, David. J. Wetherall, "Computer Networks", Pearson Education, 5 th Edition

T3. Kurose and Ross,Computer Networking- A Top-Down approach, Pearson, 5th edition

Reference Books:

R1. Behrouz A. Forouzan, TCP/IP Protocol Suite, McGraw Hill Education, ISBN: 978-0-07-070652-1, 4th Edition.

R2.S. Keshav: An Engineering Approach to Computer Networking, Pearson R2. Natalia Olifer& Victor Olifer, ―Computer Networks: Principles, Technologies & Protocols for Network Design, Wiley India, 2011.

R3.C. Siva Ram Murthy, B. S. Manoj, Adhoc Wireless Networks: Architecture and Protocols, Pearson Education, ISBN: 978-81-317-0688-6, 1st Edition.

R4. C. K. Toh, Ad Hoc Mobile Wireless Networks Protocols and Systems, Prentice Hall, ISBN:978- 01324

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Department of Information Technology
Semester -VII
[ITM4201T]: Digital Forensic and Cyber Laws(2023 Pattern)

Teaching Scheme:	Credits:	Examination Scheme:
TH: 03 Hours/Week	TH:03	In Sem. Evaluation : 20 Marks Mid Sem. Exam : 30 Marks End Sem. Exam : 50 Marks

Course Prerequisites: Computer Network

Course Objectives:

- To understand cyber laws and cyber-Crimes.
- To understand types of cyber-Crimes and its countermeasures.
- To understand and analyse cyber forensic methods.
- To be acquainted with cyber forensic tools.

Course Outcomes: After successful completion of the course, students will able to-

CO1: Describe computer forensics fundamentals for investigations, data recovery and evidence handling.

CO2: Apply concepts of forensics tools to investigate cybercrime, email violations, and data-hiding techniques.

CO3: Apply knowledge of data and Network Forensic with necessary tools.

CO4: Analyze the ethical, social, and political issues in e-commerce, focusing on privacy, intellectual property, and legal protections.

Course Contents

UNIT-I	Introduction to Cyber Crime	07 Hours

Introduction to cybercrime, Definition and types of cybercrimes, electronic evidence and handling, electronic media, collection, searching and storage of electronic media, introduction to internet crimes, hacking and cracking, credit card and ATM frauds, web technology, cryptography, emerging digital crimes and modules.

UNIT-II	Cyber Forensic and Computer Crimes– I	07 Hours

Introduction : Conventional Crime, Cyber Crime, Reasons for Cyber Crime, Classification of Conventional and Cyber Crime, Distinction between Conventional and Cyber Crime, Cyber Criminal Mode and Manner of Committing Cyber Crime, Computer Crime Prevention Measures Crimes targeting Computers : Unauthorized Access, Packet Sniffing, Malicious Codes including Trojans, Viruses, Logic Bombs, etc.

'UNIT-III	Cyber Forensic and Computer Crimes – II	07 Hours

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Online based Cyber Crimes, Phishing and its Variants, Web Spoofing and E-mail Spoofing, Cyber		
Stalking, Web defacement, Financial Crimes, ATM and Card Crimes etc., Spamming, Commercial espionage and Commercial Extortion online, Software and Hardware Piracy, Money Laundering, Fraud and Cheating		
UNIT-IV	**Forensic Tools and Processing of Electronic Evidence**	**07 Hours**
Introduction to Forensic Tools, Usage of Slack space, tools for Disk Imaging, Data Recovery, Vulnerability Assessment Tools, Encase and FTK tools, Anti Forensics and probable counters, retrieving information, process of computer forensics and digital investigations, processing of digital evidence, digital images, damaged SIM and data recovery, multimedia evidence, retrieving deleted data: desktops, laptops and mobiles, retrieving data from slack space, renamed file, ghosting, compressed files.		
UNIT-V	**Introduction to Mobile Forensics– I**	**07 Hours**
Mobile Phone Basics Inside Mobile devices : Cell Phone Crime, SIM Card, SIM Security **Mobile forensics** : Mobile forensic & its challenges **Mobile phone evidence extraction process** : The evidence intake phase, The identification phase, The preparation phase, The isolation phase, The processing phase, The verification phase, The document and reporting phase, **The presentation phase Practical mobile forensic approaches** : Mobile operating systems overview, Mobile forensic tool levelling system, Data acquisition methods.		
UNIT-VI	**Provisions in Indian Laws – I**	**07 Hours**
Provisions in Indian Laws: Indian Panel Code, Cyber laws: Indian Perspective, IT Act2000, Penalties Under IT Act, Offences Under IT Act, Establishment of Authorities under IT Act and their functions, powers, etc.: Controller, Certifying Authorities, Cyber Regulation Appellate Tribunal, Adjudicating officer.		

Text Books:

T1. Cyber Security, Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunit Belapure, Wiley Publications.

T2. Computer Forensics, Computer Crime Investigation by John R,Vacca, Firewall Media, New Delhi.

T3. Computer Forensics and Investigations by Nelson, Phillips Enfinger, Steuart, CENGAGE Learning

Reference Books:

R1. Real Digital Forensics by Keith j.Jones, Richard Bejitlich,Curtis W.Rose ,Addison Wesley Pearson Education

R2. Forensic Compiling, A Tractitioneris Guide by Tony Sammes and Brain Jenkinson, Springer International edition.

R3. Computer Evidence Collection &Presentation by Chrostopher L.T. Brown, Firewall Media

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Department of Computer Science and Business Systems
Multidisciplinary Minor (offered to other Departments)
Structure (Effective from 2024-25)

Course Code	Course	Teaching Scheme				Credit	Examination Scheme			Total Marks
		L	T	P	Hr	C	ISE	MSE	ESE	
S. Y. Sem IV										
CBM2201T	Business Information System	3	-	-	3	3	20	30	50	100
T. Y. Sem V										
CBM3201T	Data Analytics for Business	3	-	-	3	3	20	30	50	100
CBM3201L	Data Analytics for Business Lab	-	-	2	2	1	ISCE: 30		20	50
T. Y. Sem VI										
CBM3202T	Marketing Management and Marketing Research	3	-	-	3	3	20	30	50	100
B.Tech. Sem VII										
CBM4201T	IT Project Management	3	-	-	3	3	20	30	50	100
CBM4201L	IT Project Management Lab	-	-	2	2	1	ISCE: 30		20	50

Abbreviations:

L – Lecture, **T** – Tutorial, **P** – Practical, **Hr** – Hours, **C** – Credits, **ISE** – In Semester Evaluation, **MSE** – Mid Semester Evaluation, **ESE** – End Semester Evaluation

Notes:

For Theory courses: There shall be MSE, ISE and ESE. The ESE is a separate head of passing.
For Lab courses: There shall be continuous assessment (ISCE consists of ISE and MSE). The ESE is a separate head of passing.
For Tutorial: Assessment shall be ISE of the respective course.

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S. Y. B. Tech (Computer Science Business Systems)
Multidisciplinary Minor (offered to other Departments)
Academic Year – 2024-2025 Semester -IV
[CBM2201T]: Business Information Systems

Teaching Scheme:	Credit	Examination Scheme:
TH: 3 Hours/Week	TH: 03	In Sem. Evaluation : 20 Marks Mid Sem. Exam : 30 Marks End Sem. Exam : 50 Marks

Course Prerequisites : Fundamentals of Computer Programming

Course Objective:

To introduce students to the role of information systems in business operations and decision-making.

Course Outcome:

After successful completion of the course, students will able to:

CO1: Apply business communication strategies and principles to prepare effective communication for workplace situations

CO2: Analyse ethical, legal, cultural, and global issues affecting business Communication.

CO3: Analyze the implementation of appropriate organizational formats and channels in business communication.

CO4: Analyze information sources and compile information using appropriate technology and information systems.

CO5: Design organizational communication that effectively uses presentations, reports, and mass communication

Course Contents

UNIT-I	Introduction to Business Information Systems	06 Hours

Definition of Business Information Systems (BIS), role of information systems in business strategy and operations,The importance of information systems for decision-making and competitive advantage, Components of BIS:,Types of Information Systems

Case Study : (MIS and DSS tools) Infosys and Amazon

UNIT-II	IT Infrastructure for Business	06 Hours

Basics of Networking and Cloud Computing: Types of networks: LAN, WAN, and Cloud networks, Cloud computing models: IaaS, PaaS, SaaS, Cloud deployment models: Public, Private, Hybrid, Benefits of cloud computing for businesses: scalability, flexibility, cost savings,

Role of Databases in Business Information Systems: Database types: Relational, NoSQL, and Distributed databases, The role of data storage, management, and retrieval in business operations, Basics of SQL for data querying

Case Study : (In relation to Diverse Customer Requirement) HDFC Bank & Microsoft

UNIT-III	Business Process Integration and Automation	06 Hours

Business Process Integration :Understanding end-to-end business processes and their impact on system design, Integrating various business functions (finance, HR, production, and sales) into a unified

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information system, ERP and Its Applications in Business, Understanding ERP: Architecture and Modules, Finance: Managing financial data (e.g., accounting, budgeting),Human Resources: Employee records, payroll management, and recruitment, Supply Chain Management: Managing procurement, logistics, and inventory, Customer Relationship Management: Managing customer data and interactions.

Case Study: Flipkart and Walmart

UNIT-IV	Emerging Technologies in Information Systems- I	05 hours

Blockchain in Business Processes: Fundamentals of Blockchain technology and its potential impact on business (e.g., transparency, security), Use cases in business: supply chain management, secure transactions, and contract management.

Internet of Things (IoT): How IoT connects devices and businesses, creating data-driven ecosystems, and it Applications

Case Study: Reliance Jio and Tesla

UNIT-V	Advanced Technologies in Information Systems	06 hours

Introduction to AI in Business: Understanding automation, machine learning, and predictive analytics.AI Applications in Business: Customer Service: Chatbots that provide instant support. Marketing: Personalized recommendations and targeted advertising. Human Resources: AI tools for talent acquisition and performance analytics.

Impact of Mobile Platforms: Extending business systems to smartphones and tablets for better accessibility.

Cloud-Based Applications: Enhancing flexibility and scalability for businesses through SaaS, PaaS, and IaaS. Supporting mobile processes like remote work and on-the-go decision-making.

UNIT-VI	Ethical and Legal Considerations in Business Information Systems	07 Hours

Data Privacy and Cyber security Regulations: Overview of data protection laws: GDPR, CCPA, HIPAA, Legal requirements for handling personal and sensitive business data, Best practices in cyber security to protect business systems,

Ethical Use of Information Systems: Ethical dilemmas in data collection, data analysis, and decision-making, Privacy concerns in business information systems: balancing innovation and ethical responsibility, The role of corporate governance in ensuring ethical IT practices.

Case Study: TCS (Tata Consultancy Services) and Facebook (Meta)

Text Books:

T1. Shirley Taylor, *Comunication for Business; A Practical Approach* (2005), Shirley Taylor, (4th ed.) Pearson Education

T2. Bisen & Priya , *Business Communication, New Age International Publication*

Reference Books:

R1. Management Information Systems: Managing the Digital Firm"By Kenneth C. Laudon and Jane P. Laudon

R2. Introduction to Information Systems By R. Kelly Rainer, Brad Prince, and Casey G. Cegielski

R3. Business Information Systems" by Paul Bocij, Andrew Greasley, and Simon Hickie

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T. Y. B. Tech (Computer Science Business Systems)
Multidisciplinary Minor (offered to other Departments)
Academic Year – 2024-2025 Semester -V
[CBM3201T]: Data Analytics for Business

Teaching Scheme:	Credit	Examination Scheme:
TH: 3 Hours/Week	TH:3	ISCE : 20 Marks
PR: 2 Hours/Week	PR: 1	Mid Sem. Exam : 30 Marks
		End Sem. Exam : 50 Marks
		Lab Evaluation : 50 Marks

Course Prerequisites :

- Basic knowledge of Mathematics (algebra and statistics).
- Fundamental computer skills (familiarity with Excel or equivalent tools).
- Interest in problem-solving and decision-making using data.

Course Objective:

- Understand the importance of data analytics in business decision-making.
- Learn to prepare and clean real-world datasets for analysis.
- Apply exploratory data analysis (EDA) methods to derive insights from business data.
- Use statistical techniques like regression and hypothesis testing to solve business problems.
- Develop skills in creating data visualizations and communicating insights through storytelling.

Course Outcome:

After successful completion of the course, students will able to:

CO1. Explain the role and importance of data analytics in business decision-making.
CO2. Implement data preparation and cleaning processes to handle real-world datasets.
CO3. Analyze and interpret business datasets using exploratory data analysis (EDA) techniques to derive meaningful insights.
CO4. Apply statistical methods like regression and hypothesis testing for solving business problems.
CO5. Design effective data visualizations and interpret business trends using storytelling techniques.

Course Contents

UNIT-I	Introduction to Data Analysis (CO1)	05 Hours

Definition and significance of data analytics in business, Types of data analytics: Descriptive, Diagnostic, Predictive, Prescriptive, Data-driven decision-making in business contexts, Overview of data types and structures: structured, unstructured, and semi-structured data.

UNIT-II	Data Preparation and Cleaning	06 Hours

Data collection methods and identifying data sources, Handling missing data, inconsistent entries, and outliers, Data transformation techniques: scaling, encoding, and formatting, Introduction to libraries like Pandas and NumPy in Python for data cleaning.

UNIT-III	Exploratory Data Analysis (EDA)	06 Hours

Understanding the dataset: summary statistics (mean, median, variance, etc.), Visualization techniques: histograms, boxplots, scatter plots, and correlation heatmaps, Identifying patterns, trends, and anomalies in data, Hands-on with Python for EDA using Matplotlib and Seaborn libraries.

UNIT-IV	Data Visualization and Dash-boarding	06 Hours

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Importance of visualization in business storytelling, Best practices for creating effective visualizations. Tools for visualization: Power BI, Tableau, and Python, Creating interactive dashboards and reports. Hands-on project: Build a sales or marketing dashboard,
Case Study Presentation: Students present their analysis of a real-world dataset.

UNIT-V	Statistical Methods for Business	08 Hours

Introduction to statistical concepts: probability, distributions, and sampling, Time series analysis, Hypothesis testing: t-tests, chi-square tests, and ANOVA, Correlation and regression analysis: linear and multiple regression, cluster analysis(kmeans, hierarchical),Decision Tree

UNIT-VI	Real-world Business Applications and Case Studies	06 Hours

Ethical Considerations in Business Analytics: Principles of responsible data handling: consent, transparency, and accountability. Mitigating algorithmic bias and ensuring fairness in decision-making.
Sales Analytics: Techniques for sales forecasting using historical data using ARIMA, Identifying sales trends and seasonality, Ethical considerations in using customer sales data (e.g., privacy and transparency).
Customer Segmentation: Application of clustering techniques (e.g., K-Means, hierarchical) to group customers based on behavior or demographics, Strategies for personalized marketing, Ethical implications of targeted advertising and bias in segmentation.
Marketing Campaign Analytics: Evaluating the ROI of marketing campaigns (Regression and hypothesis testing), Analyzing customer engagement metrics and optimizing marketing strategies, Ethical concerns in using personal data for campaign analysis.
4. Financial Risk Analytics: Portfolio risk assessment and fraud detection, Predicting credit defaults using regression models, decision trees, hypothesis testing. Addressing fairness and bias in financial decision-making models.

Text Books:

T1."Data Analytics Made Accessible" by Anil Maheshwari.
T2."Business Analytics: Data Analysis and Decision Making" by S. Christian Albright and Wayne L. Winston.

Reference Books:

R1. "Practical Statistics for Data Scientists" by Peter Bruce and Andrew Bruce.
R2."Storytelling with Data: A Data Visualization Guide for Business Professionals" by Cole Nussbaumer Knaflic.
R3."The Visual Display of Quantitative Information" by Edward Tufte."Python for Data Analysis" by Wes McKinney.

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T. Y. B. Tech (Computer Science Business Systems)
Multidisciplinary Minor (offered to other Departments)
Academic Year – 2024-2025 Semester -V
[CBM3101L]: Data Analytics for Business Lab

Teaching Scheme:	Credit	Examination Scheme:
Practical : 2 Hours	PR:01	ISCE: 30 Marks End Sem. Exam: 20 Marks

Course Prerequisites:

1. To introduce students to tools and techniques for analyzing business data.
2. To develop skills in exploratory data analysis (EDA) and visualization.
3. To enable students to apply statistical methods to real-world business problems.
4. To equip students with hands-on experience using tools like Python, Power BI, and Tableau

Laboratory Objectives:

1. Equip students with hands-on skills in data analysis, cleaning, and visualization using Python and tools like Power BI/Tableau.
2. Enable the application of statistical and machine learning techniques to solve business challenges through real-world case studies.
3. Foster the ability to create interactive dashboards and communicate data-driven insights effectively.

Laboratory Outcome:

LO1. After successful completion of the laboratory course, students will able to:
LO2. Apply data cleaning, preparation, and exploratory analysis techniques using Python libraries such as Pandas and NumPy.
LO3. Create impactful visualizations and interactive dashboards using tools like Power BI, Tableau, or Matplotlib to derive business insights..
LO4. Implement statistical and machine learning models (e.g., regression and clustering) for analyzing and solving business problems.
LO5. Solve real-world business case studies and present actionable insights based on data-driven analysis.

Guidelines for Assessment

1. Lab assessment (term work) shall be based on ISCE.
2. There shall be continuous assessment (ISCE consists of ISE and MSE).
3. ISCE consist of Continuous assessment of 20 marks shall be based on experiments performed, submission of results of program in the form of report/journal, timely completion, attendance, understanding, efficient codes, punctuality and neatness & Mid Semester exam would be conducted for 30 marks
4. End semester Practical examination of 50 marks shall be based on the Practical Lab performance.
5. ESE is a separate head of passing.
6. All laboratory assignments should be conducted using any tool like Python, Excel,Tableau or Power BI.

List of Laboratory Assignments/Experiments

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1	Data cleaning and preparation using Python (Pandas, NumPy).
2	Exploratory Data Analysis (EDA) on a sales dataset (Matplotlib/Seaborn).
3	Creating a dashboard for marketing trends using Tableau or Power BI.
4	Implementing linear regression for predicting sales.
5	Hypothesis testing on customer behavior data.
6	Correlation analysis and visualization of financial data.
7	Cluster analysis for customer segmentation.
8	Building an interactive business report in Power BI/Tableau.

Text Books:

T1."Data Analytics Made Accessible" by Anil Maheshwari.

T2."Business Analytics: Data Analysis and Decision Making" by S. Christian Albright and Wayne L. Winston.

Reference Books:

R1. "Practical Statistics for Data Scientists" by Peter Bruce and Andrew Bruce.

R2."Storytelling with Data: A Data Visualization Guide for Business Professionals" by Cole Nussbaumer Knaflic.

R3."The Visual Display of Quantitative Information" by Edward Tufte.**"**Python for Data Analysis" by Wes McKinney.

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Director RSCOE, Pune

T. Y. B. Tech (Computer Science Business Systems)
Multidisciplinary Minor (offered to other Departments)
Academic Year – 2024-2025 Semester -VI
[CBM3202T]: Marketing Research and Marketing Management

Teaching Scheme:	Credit	Examination Scheme:
TH: - 03 Hours/Week	TH: 03	In Sem. Evaluation :15 Marks Mid Sem. Exam : 25 Marks End Sem. Exam : 60 Marks

Course Prerequisites: Economics [HS1101], Fundamentals Of Management And Strategy Foundation[HS3102]

Course Objective:

- Learn marketing concepts and consumer changing behavior
- Demonstrate product management, Branding & Labeling packaging strategies
- Assimilate marketing communication

Course Outcome:

After successful completion of the course, students will able to:

CO 1: Explain the basic marketing concepts.
CO 2: Comprehend the dynamics of marketing and analyze how various components interact with each other in the real world.
CO 3: Leverage marketing concepts for effective decision making.
CO 4: Determine the pricing and distribution strategies
CO 5: Explain the basic concepts and the application of statistical tools in marketing research.
CO 6: Explain the internet marketing, Business to Business marketing, Promotion in business markets, CRM and Strategies adopted in B2B markets.

Course Contents

UNIT-I	Marketing Concepts and Applications	06 Hours

Introduction to Marketing & Core Concepts, Marketing of Services, Importance of marketing in service sector. Marketing Planning & Environment: Elements of Marketing Mix, Analyzing needs & trends in Environment - Macro, Economic, Political, Technical & Social Understanding the consumer: Determinants of consumer behavior, Factors influencing consumer behavior, Market Segmentation: Meaning & Concept, Basis of segmentation, selection of segments, Market Segmentation strategies, Target Marketing, Product Positioning, Business value proposals: eg how to add more value to existing market/business, value can be end customer satisfaction/retentions, attracting new potential end customers, revenue etc.

Case Study: Google Cloud Services – How Google uses segmentation and value propositions to retain enterprise customers.

UNIT-II	Product Management	06 Hours

Product Life cycle concept, New Product development & strategy, Stages in New Product development, Product Testing and QA, Product decision and strategies, Branding & packaging. Feedback of Customer and Consumer.

Case Study: Apple's iPhone Evolution – Product lifecycle management and consumer feedback

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integration.		
UNIT-III	**Pricing, Promotion and Distribution Strategy**	**06 Hours**
Policies & Practices – Pricing Methods & Price determination Policies. Marketing Communication – The promotion mix, Advertising & Publicity, 5 M's of Advertising Management. Marketing Channels, Retailing, Marketing Communication, Advertising **Case Study: Netflix's Pricing Strategy – Balancing subscription-based pricing and promotional offers globally.**		
UNIT-IV	**Marketing Research**	**06 Hours**
Introduction, Type of Market Research, Scope, Objectives & Limitations, Marketing Research Techniques, Survey Questionnaire design & drafting, Pricing Research, Media Research, Qualitative Research, Data Analysis: Use of various statistical tools – Descriptive & Inference Statistics, Statistical Hypothesis Testing, Multivariate Analysis - Discriminant Analysis, Cluster Analysis, Segmenting and Positioning, Factor Analysis, Digital Marketing, Social Marketing and E-commerce **Case Study:** Intel, IBM, Microsoft Azure Case study		
UNIT-V	**Internet Marketing**	**06 Hours**
Introduction to Internet Marketing. Mapping fundamental concepts of Marketing (7Ps, STP); Strategy and Planning for Internet Marketing, Social Media Marketing, Digital Marketing and Ecommerce **Case Study: Facebook's Ad Algorithms – How social media marketing drives personalized consumer engagement.**		
UNIT-VI	**Business to Business Marketing**	**06 Hours**
Fundamental of business markets. Organizational buying process. Business buyer needs. Market and sales potential, Product in business markets, Price in business markets. Place in business markets. Promotion in business markets, Relationship, networks and customer relationship management. Business to Business marketing strategy. **Case Study: Rovio Entertainment (Angry Birds) – Building partnerships and growth in a B2B market.**		

Text Books:

T1. Marketing Management (Analysis, Planning, Implementation & Control) – Philip Kotler
T2. Fundamentals of Marketing – William J. Stanton & Others
T3. Marketing Management – V.S. Ramaswamy and S. Namakumari
T4. Marketing Research – RajendraNargundkar
T5. Market Research – G.C. Beri
T6. MarketResearch, Concepts, & Cases – Cooper Schindler

Reference Books:

R1: Marketing Management – RajanSaxena
R2: Marketing Management – S.A. Sherlekar
R3: The IUP Journal of Marketing Management, Harvard Business Review
R4: Research for Marketing Decisions by Paul Green, Donald, Tull
R5: Business Statistics, A First Course, David M Levine at al, Pearson Publication

Links:

- https://onlinecourses.nptel.ac.in/noc21_mg51/preview
- https://www.edx.org/course/marketing management?index=product&queryID=d757b8fcf377b56ab5f232913 737553&position=1
- https://www.edx.org/course/marketing-management 2?index=product&queryID=3f97462d431d5de04821d99a5a8ce238&p osition=2

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B. Tech (Computer Science Business Systems)
Multidisciplinary Minor (offered to other Departments)
Academic Year – 2024-2025 Semester -VII
[CBM4201T]: IT Project Management

Teaching Scheme:	Credit	Examination Scheme:
TH: 3 Hours/Week	TH:3	ISCE : 20 Marks Mid Sem. Exam : 30 Marks End Sem. Exam : 50 Marks

Course Prerequisites :

- Basic knowledge of Project Management
- Fundamental computer skills (familiarity with Excel or equivalent tools).
- Interest in problem-solving and decision-making using data.

Course Objective:

- To identify the fundamental aspects of project management, including project overview, feasibility studies, and project scheduling, to facilitate effective planning and execution.
- To demonstrate the ability to apply project scheduling techniques such as PERT and CPM, critical path calculation, and cost reduction strategies for efficient project management.
- To analyze and implement cost control measures, resource scheduling, and risk analysis practices to ensure project success and stakeholder satisfaction.
- To evaluate Agile project management principles and methodologies, including Scrum and DevOps, to understand their significance in modern IT projects..

Course Outcome:

After successful completion of the course, students will able to:

CO1. Define the fundamental principles of software engineering and the characteristics of quality software**.**

CO2. Explain the key features of software process models, including the Waterfall, Incremental, and Agile models.

CO3. Apply the techniques of requirements elicitation and specification to create a Software Requirements Specification (SRS) document for a given case study.

CO4. Identify and demonstrate the application of project scheduling techniques like PERT, CPM, and float calculation to create efficient project schedules and manage project timelines effectively

CO5. Implement cost control measures utilizing PERT/Cost and resource scheduling techniques, and conduct risk analysis to ensure project completion within constraints

CO6. Describe Agile project management principles, methodologies, and their relationship with Scrum, Lean, DevOps, and IT Service Management, along with an overview of other Agile methodologies.

Course Contents

UNIT-I	Introduction to Software Engineering	6 Hours

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Software Engineering Fundamentals: Nature of Software, Software Engineering Principles, The Software Process, Software Myths. Quality software characteristics. The Software Crisis, description of the real world using the Objects Model. Description of the Object-Oriented Analysis process vs. the Structure Analysis Model. Process Models: Generic Process Model, Prescriptive Process Models- The Waterfall, Incremental Process (RAD), Evolutionary Process, Unified Process, Concurrent. V model, W model. Advanced Process Models: Agile Process Model Methods, Plan driven and agile development, Extreme Programming (XP) Practices.

Self-Study: Agile open-source tool. JIRA

UNIT-II	Project Management & Agile Methodology	6 Hours

Overview of UML: Introduction to Unified Modeling Language (UML), History and evolution of UML, Importance and benefits of using UML in software development, UML diagrams and their categorization, UML elements: classes, objects, attributes, operations, relationships, etc. UML notation and symbols.

Project Feasibility Studies- Feasibility Analysis, Market and Demand Analysis, Project Cost Estimate, Financial Appraisal, Project Scheduling using PERT and CPM, Critical Path Calculation, Precedence Relationship, Float Calculation and its importance, Cost reduction by Crashing of activity. Project Cost Control (PERT/Cost), Resource Scheduling & Leveling, Project Management Features: Risk Analysis, Project Control, Project Audit and Project Termination Theories for Agile Management, Agile Software Development, Traditional Model vs. Agile Model, Classification of Agile Methods, Agile Manifesto and Principles, Agile, Project Management, Agile Team Interactions, Ethics in Agile Teams, Agility in Design, Testing, Agile Documentations, Agile Drivers, Capabilities and Values Agile Processes.

UNIT-III	Agile Process	6 Hours

Lean Production, SCRUM, Crystal, Feature Driven Development, Adaptive Software Development, Extreme Programming: Method Overview, Lifecycle Work Products, Roles and Practices Introduction, Agile Principles, Agile methodologies, Relationship between Agile Scrum,

Self-study: Other Agile Methodologies: Introduction to XP, FDD, DSDM, Crystal

UNIT-IV	Scrum	6 Hours

Scrum: Various terminologies used in Scrum (Sprint, product backlog, sprint backlog, sprint review, retro perspective), various roles (Roles in Scrum), Best practices of Scrum. Scrum Overview, Scrum Pillars, Scrum Values, Scrum Team Roles, Scrum Ceremonies/Events(Sprint, Sprint Planning, Daily Scrum, Sprint Review, Sprint Retrospective), User Story Estimation Techniques, Scrum Artifacts, Scrum best practices, Introduction to SAFe. SAFe roles and responsibilities

UNIT-V	DevOps Essentials	8 Hours

Overview and its Components, Containerization Using Docker, Managing Source Code and Automating Builds, Automated Testing and Test Driven Development, Continuous Integration, Configuration Management, Continuous Deployment, Automated Monitoring.

UNIT-VI	GIT and Puppet	8 Hours

GIT: Build Tools – GIT and Jenkins Introduction to VCS and GIT, GIT File workflow, Important GIT Commands, Plugin Management in Jenkins, Introduction to Continuous Integration and Jenkins, Various scenarios of Building Delivery Pipeline, Build Setup in Jenkins, Test Automation, Security in Jenkins, Notification System

Puppet -Puppet Introduction, Puppet Architecture, Basic Puppet Terminologies, Puppet Language

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Constructs, Puppet Modules, Puppet Environment, Node Classification, Puppet Classes, Puppet Template

Text Books:

T1. Roger Pressman, Software Engineering: A Practitioner's Approach, McGraw Hill, ISBN 0–07–337597–7.

T2. Ian Sommerville, Software Engineering, Addison and Wesley, ISBN 0-13-703515-2.

T3. Bernd Bruegge and Allen H. Dutoit "Object-Oriented Software Engineering: using UML, Patterns, and Java".

T4. Hassan Gomaa, "Software Modeling and Design- UML, Use cases, Patterns and Software Architectures" Cambridge University Press, 2011, ISBN 978-0-521-76414-8.

Reference Books:

R1. Carlo Ghezzi, Fundamentals of Software Engineering", Prentice Hall India, ISBN-10:
   i. 0133056996.

R2. Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India, ISBN-13: 978-
   a. 8120348981.

R3. Pankaj Jalote, An Integrated Approach to Software Engineering, Springer, ISBN 13:
   a. 9788173192715.

R4. S K Chang, Handbook of Software Engineering and Knowledge Engineering, World
   a. Scientific, Vol I, II, ISBN: 978-981-02-4973-1.

R5. Erich Gamma, Richard Helm, Ralph Johnson, and John M. Vlissides "Design Patterns:
   a. Elements of Reusable Object-Oriented Software".

R6. Gardy Booch, James Rambaugh, Ivar Jacobson," The unified modeling language user guide", Pearson Education, Second edition, 2008, ISBN 0-321-24562-8

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

B. Tech (Computer Science Business Systems)
Multidisciplinary Minor (offered to other Departments)
Academic Year – 2024-2025 Semester -VII
[CBM4201L]: IT Project Management Lab

Teaching Scheme:	Credit	Examination Scheme:
Practical : 2 Hours	PR:01	ISCE: 30 Marks End Sem. Exam: 20 Marks

Course Prerequisites:

- To introduce students to tools and techniques for design sytem bypaper pencil method
- To develop skills Future plan execution for nay project
- To enable students to apply critical thinking for feasibility study for system.
- To equip students with hands-on experience using tools like Python, Power BI, and Tableau

Laboratory Objectives:

- To understand different architectural designs and to transform them into proper model.
- To transform requirement document to appropriate design.
- To understand testing strategies.
- To choose and use modern design tools for project development and implementation.
- To transform requirement document to appropriate design.
- To perform requirement analysis and designing using UML diagram modelling
- To understand testing strategies.
- To choose and use modern design tools for project development and implementation

Laboratory Outcome:

After successful completion of the laboratory course, students will able to:

CO 1: Explain the fundamental concepts of Software Engineering Lifecycle models.
CO 2: Summarize the software requirement specifications and the SRS documents.
CO 3: Analyze various design and development solutions.
CO 4: Describe the software reliability and quality concepts.
CO 5: Explain risk and configuration management.
CO 6: Illustrate software testing methodologies.

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Guidelines for Assessment

1. Lab assessment (term work) shall be based on ISCE.
2. There shall be continuous assessment (ISCE consists of ISE and MSE).
3. ISCE consist of Continuous assessment of 20 marks shall be based on experiments performed, submission of results of program in the form of report/journal, timely completion, attendance, understanding, efficient codes, punctuality and neatness & Mid Semester exam would be conducted for 30 marks
4. End semester Practical examination of 50 marks shall be based on the Practical Lab

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performance.

5. ESE is a separate head of passing.
6. All laboratory assignments should be conducted using any tool like UML designer, Excel,Tableau or JIRA,SCRUM etc

List of Laboratory Assignments	
1	Write Software Requirement Specification (SRS) document for any system.
2	Design Data Flow diagram for the system selected in assignment number one.
3	Design Use cases and implement Use case diagram for the system selected in assignment number one.
4	Design basic class diagrams to identify and describe key concepts like classes and their relationships.
5	Design Activity Diagram for the system selected in assignment number one.
6	**Mini Project** Students should implement any project using scrum, DevOps, GIT, & Agile methodologies.

Text Books:

T1. Roger Pressman, Software Engineering: A Practitioner's Approach, McGraw Hill, ISBN 0–07–337597–7.

T2. Ian Sommerville, Software Engineering, Addison and Wesley, ISBN 0-13-703515-2.

T3. Bernd Bruegge and Allen H. Dutoit "Object-Oriented Software Engineering: using UML, Patterns, and Java".

T4. Hassan Gomaa, "Software Modeling and Design- UML, Use cases, Patterns and Software Architectures" Cambridge University Press, 2011, ISBN 978-0-521-76414-8.

Reference Books:

R1. Erich Gamma, Richard Helm, Ralph Johnson, and John M. Vlissides "Design Patterns:

R2. Elements of Reusable Object-Oriented Software"

R3. Gardy Booch, James Rambaugh, Ivar Jacobson," The unified modeling language user guide", Pearson Education, Second edition, 2008, ISBN 0-321-24562-8

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Department of Automation and Robotics
Multidisciplinary Minor (offered to other Departments)
Multidisciplinary Minor in Industrial Automation and Robotics
Structure (Effective from 2024-25)

Course Code	Course	Teaching Scheme				Credit	Examination Scheme			Total Marks
		L	T	P	Hr	Cr	ISE	MSE	ESE	
S. Y. Sem IV										
ARM2201T	Industrial Sensors and its applications	3	-	-	3	3	20	30	50	100
T. Y. Sem V										
ARM3201T	Robotics and its applications	3	-	-	3	3	20	30	50	100
ARM3201L	Robotics and its applications Laboratory	-	-	2	2	1	ISCE: 30		20	50
T. Y. Sem VI										
ARM3202T	Essentials of Industrial Automation	3	-	-	3	3	20	30	50	100
B. Tech. Sem VII										
ARM4201T	Fundamentals of PLC and SCADA	3	-	-	3	3	20	30	50	100
ARM4201L	Fundamentals of PLC and SCADA Laboratory	-	-	2	2	1	ISCE: 30		20	50
Total		**12**	**-**	**4**	**16**	**14**				**500**

Abbreviations:

L – Lecture, **T** – Tutorial, **P** – Practical, **Hr** – Hours, **C** – Credits, **ISE** – In Semester Evaluation, **MSE** – Mid Semester Evaluation, **ESE** – End Semester Evaluation

Notes:
For Theory courses: There shall be MSE, ISE and ESE. The ESE is a separate head of passing.
For Lab courses: There shall be continuous assessment (ISCE consists of ISE and MSE). The ESE is a separate head of passing.
For Tutorial: Assessment shall be ISE of the respective course

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S. Y. B. Tech. (Automation and Robotics)
Academic Year – 2024-2025 Semester -IV
Multi-Disciplinary Minor -I
ARM2201T: Industrial Sensors and its applications

Teaching Scheme: TH:03 Hours/Week	Credit TH:03	Examination Scheme: TH In Sem. Evaluation:20 Marks Mid Sem. Exam: 30 Marks End Sem. Exam: 50 Marks

Course Prerequisites: Basics of sensing elements, bridges and basic electronics Course

Course Objective:
1. To introduce the fundamentals of electrical measurements and instrumentation
2. To Understand basic principles of sensing various parameters
3. To Develop mathematical background of sensor design
4. To Learn selection of sensors for typical applications
5. To Understand basic principles of advance sensors
6. To Understand the fundamentals of vision based sensors

Course Outcome:
After successful completion of the course, students will able to:
CO1: Explain the principles of operation of the main types of sensors
CO2: Utilize the merits of various types of sensors for a wide range of applications.
CO3: Analyze the specifications of various types of sensors
CO4: Understand the main characteristics of sensors
CO5: Select appropriate sensors for a given application and design simple electronic sensor interface systems.
CO6 : Select components for instrumentation systems

Course Contents

UNIT-I	Introduction	07 Hours

Basics of measurement–Significance of measurement–Units and Standards–Calibration techniques–Errors in measurement–Generalized measurement system–Sensors and Transducers–Classification of transducer–Static and dynamic characteristics of transducer–Sensor calibration techniques. Criteria for selection of sensors- range, dynamic range, sensitivity, Linearity, response time, band width, accuracy, repeatability & precision, Resolution & threshold, type of output, size and weight, environmental conditions, interfacing.

UNIT-II	Displacement, Force and Pressure	07 Hours

Position / Displacement sensors - Potentiometric Sensor –Capacitive sensors – Inductive and Magnetic sensors – LVDT, RVDT, Eddy Current, Hall effect, Magneto resistive, Magneto strictive – Ultrasonic – Radar – Strain Gauge – Tactile Sensor – Piezo electric Bellows, Membranes, and Thin Plates–Piezo-resistive Sensors–Vacuum sensor–

UNIT-III	Temperature Sensors	07 Hours

Thermistors: Semiconductor Resistance versus Temperature, Thermistor Characteristics,
THERMOCOUPLES: Thermoelectric Effects, Thermocouple Characteristics, Thermocouple Sensors,
Other thermal sensor: Bimetal Strips, Gas Thermometers, Vapor Pressure Thermometers, Liquid-Expansion Thermometers Solid-State Temperature Sensors, Design considerations

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UNIT-IV	Optical, Vibration and Acoustic Sensors	07 Hours
Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors, Vibrations sensors – accelerometers etc. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.		
UNIT-V	**Range, Heading and Advanced Sensors**	**07 Hours**
Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR) – Heading Sensors – GPS, Compass – Humidity sensor – Hygrometer – Radiation Sensors – Scintillation, Ionization detector – Gas Sensors – Bio sensor		
UNIT-VI	**Vision Based Sensors**	**07 Hours**
Vision based sensors- Elements of vision sensor, image acquisition, image processing, edge detection, feature extraction, object recognition, pose estimation and visual serving, hierarchy of a vision system, CCD and CMOS Cameras, Monochrome, stereovision, night vision cameras, still vs video cameras, kinect sensor; Block schematic representations**.**		

Text Books:

T1. Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009

T2. Sawney A K and Puneet Sawney, “A Course in Mechanical Measurements and Instrumentation and Control”, 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

T3. Peter Elgar, "Sensors for Measurement and Control", Addison-Wesley Longman Ltd, 1998.

Reference Books:

R1.C.Sujatha, W . Dyer,S.A.,SurveyofInstrumentationandMeasurement,JohnWiley&Sons,Canada,2001

R2. Hans Kurt Tönshoff (Editor),Ichiro, “Sensors in Manufacturing”Volume1,Wiley-VCHApril2001.

R3.John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.

R4.PatranabisD,“Sensorsand Transducers”,2nd Edition,PHI,NewDelhi,2011.

R5.RichardZurawski,“IndustrialCommunication Technology Handbook”2nd edition,CRCPress,2015

R6. Robert B. Northrop, "Introduction to Instrumentation & Measurements", 3rd Edition, CRC Press, 2014.

On-Line resources:

1. https://nptel.ac.in/courses/108108147
2. https://archive.nptel.ac.in/courses/108/105/108105064/
3. https://onlinecourses.nptel.ac.in/noc19_ee44/preview
4. http://www.mfg.mtu.edu/cyberman/machtool/machtool/sensors/fundamental.html

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2025-2026 Semester –V

ARM3201T: Robotics and its applications

Multi-Disciplinary Minor -II

Teaching Scheme:	Credit	Examination Scheme: TH
TH:03 Hours/Week	TH:03	In Sem. Evaluation:20 Marks Mid Sem. Exam: 30 Marks End Sem. Exam: 50 Marks

Prerequisite Courses

Engineering Mechanisms and their Application, Introduction to Manufacturing, Matrices, Vectors, Electrical Technology, Industrial Electronics

Course Objectives

1. To introduce various types of Robots and the functional elements of Robotics
2. To impart knowledge of robot drive systems
3. To introduce various types the end effectors
4. To educate on various sensors used in Robotic automation
5. To introduce the basic mathematical modeling of a robot
6. To impart knowledge of basics of Robot Programming and robotic Applications

Course Outcomes

After successful completion of the course, students will able to:

CO1: UNDERSTAND basic concepts of robotics

CO2: SELECT appropriate drive for Robotic applications.

CO3: To COMPARE and SELECT robot and end effectors as per application

CO4: To SELECT proper sensors for robot as per application requirement

CO5: To know about the basic mathematical modeling of robot

CO6: To know about the fundamentals of robot programming and applications

Course Contents

Unit I	Fundamentals of Robotics	08 Hours

Historical development of Robotics, Definitions of Industrial Robot, Type and Classification of Robots, Asimov's laws of robotics, Robot configurations, Robot Components, Robot Degrees of Freedom, Work volume and work envelope, Robot Joints and symbols, Robot Coordinates, Robot Reference Frames, Resolution, accuracy and precision of Robot, Work cell control

Unit II	Robot Drive Systems	07 Hours

Pneumatic Drives, Hydraulic Drives, Mechanical Drives, Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors, BLDC-Salient Features, Applications and Comparison of all these Drives, Micro actuators, selection of drive, Power transmission systems for robot, Motion conversion, Determination of HP of motor, Types of Gearbox: - Planetary, Harmonic, Cycloidal gearbox and gear Ratio, variable speed arrangements

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Director, RSCOE, Pune

Unit III	End Effectors	08 Hours
Grippers, Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Advance Grippers- Adaptive grippers, Soft Robotics Grippers, Tactile Sensor Grippers; Various process tools as end effectors; Robot end effectors interface, Active and passive compliance, Selection and Design Considerations		
Unit IV	**Robot Sensors**	**07 Hours**
Transducers and sensors, Sensors in robotics, Principles and applications of the following types of sensors- Proximity Sensors, Photo Electric Sensors, Position sensors – Piezo Electric Sensor, LVDT, Resolvers, Encoders – Absolute and Incremental: - Optical, Magnetic, Capacitive, pneumatic Position Sensors, Range Sensors- Range Finders, Laser Range Meters, Touch Sensors, Force and torque sensors, Safety Sensor: Light Curtain, Laser Area Scanner, Safety Switches, Machine vision		
Unit V	**Mathematical Modeling of a robot**	**08 Hours**
General Mathematical Preliminaries on Vectors & Matrices, Link Equations and relationships, Direct Kinematics, Co-ordinate and vector transformation using matrices, Rotation matrix, Inverse Transformations, Composite Rotation matrix, Homogenous Transformations, Robotic Manipulator Joint Co-ordinate System, inverse kinematics of two joints, DH Parameters, Jacobian Transformation in Robotic Manipulation		
Unit VI	**Fundamentals of Robot Programming and Applications**	**08 Hours**
Introduction to Robotic Programming, On-line and off-line programming, programming examples. Various Teaching Methods, Survey of Robot Level Programming Languages, A Robot Program as a Path in Space, Motion Interpolation, various Textual Robot Languages, Typical Programming Examples such as Palletizing, Loading a Machine Etc. Robots in manufacturing and non- manufacturing applications, a robot-based manufacturing system, robot cell design considerations and selection of robot, Robot Economics, Functional Safety in Robotic Application		

Text Books:

1. Groover, M.P. Weiss, M. Nagel, R.N. & Odrey, N.G., Ashish Dutta, Industrial Robotics, Technology, Programming & Applications, Tata McGraw Hill Education Pvt. Ltd. New Delhi
2. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.
3. Groover M.P.-Automation, production systems and computer integrated manufacturing- Prentice Hall of India.

Reference Books:

1. S B Niku, Introduction to Robotics, Analysis, Control, Applications, 2nd Edition, Wiley Publication, 2015.
2. Mikell P. Groover, Automation, Production Systems & Computer Integrated Manufacturing, PHI Learning Pvt. Ltd. , New Delhi, ISBN:987-81-203-3418-2, 2012
3. John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009
4. R K Mittal & I. J. Nagrath, Robotics and Control, McGraw Hill Publication, 2015.
5. Mike Wilson, Implementation of Robotic Systems, ISBN: 978-0-124-04733-4

On-Line resources:

1. https://onlinecourses.nptel.ac.in/noc19_me78
2. https://onlinecourses.nptel.ac.in/noc19_me74
3. https://onlinecourses.nptel.ac.in/noc20_me58

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2025-2026 Semester –V
ARM3201L: Robotics and its applications Laboratory
Multi-Disciplinary Minor -II

Teaching Scheme:	**Credit**	**Examination Scheme:**
LAB:02 Hours/Week	**LAB: 01**	**ISCE: 30 Marks** **ESE: 20 Marks** **Total: 50 Marks**

Course Prerequisites: Knowledge of basic electronics and electrical engineering.

Course Objectives

1. To introduce various types of Robots and the functional elements of Robotics
2. To impart knowledge of robot drive systems
3. To introduce various types the end effectors
4. To educate on various sensors used in Robotic automation
5. To introduce the basic mathematical modeling of a robot
6. To impart knowledge of basics of Robot Programming and robotic Applications

Course Outcome:

After successful completion of the course, students will able to:

CO1: UNDERSTAND basic concepts of robotics

CO2: SELECT appropriate drive for Robotic applications.

CO3: To COMPARE and SELECT robot and end effectors as per application

CO4: To SELECT proper sensors for robot as per application requirement

CO5: To know about the basic mathematical modeling of robot

CO6: To know about the fundamentals of robot programming and applications

Lab Contents

Guidelines for Assessment

Practical/Oral examination based on the practical's performed in the lab. The Performance will be assessed jointly by internal and external examiners.

- Total marks assigned are 25.
- Continuous assessment will be carried out based on attendance, lab performance, and timely submission of lab file

Final practical examination for specific practical and oral examination will be conducted

List of Laboratory Assignments/Experiments

1	Demonstration of automation systems in lab / industry.
2	Demonstration of various robotic configurations using industrial robot
3	Design and selection of Gripper/End effector
4	Robot programming and simulation for pick and place
5	Robot programming and simulation for Color identification

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6	Robot programming and simulation for Shape identification
7	Robot programming and simulation for machining (cutting ,welding)
8	Robot programming and simulation for simple assembly process
9	Industrial visit for study the Industrial Automation and robotic applications

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T. Y. B. Tech. (Automation and Robotics)
Academic Year – 2025-2026 Semester –VI
ARM3202T: Essentials of Industrial Automation
Multi-Disciplinary Minor -III

Teaching Scheme: TH:03 Hours/Week	Credit TH:03	Examination Scheme: TH In Sem. Evaluation:20 Marks Mid Sem. Exam: 30 Marks End Sem. Exam: 50 Marks

Course Objectives

1. To help students gain essential and basic knowledge of automated systems
2. To impart knowledge of Transfer Line & Automated Assembly
3. To introduce Pneumatic Control in automation
4. To educate on fundamentals of programmable automation
5. To introduce Hydraulic Control in automation
6. To understand the applications of automation in various sector

Course Outcome:

After successful completion of the course, students will able to:

CO1: Apply automation principles and strategies
CO2: SELECT appropriate Transfer Line and Automated Assembly.
CO3: To COMPARE and SELECT Pneumatic Control as per application
CO4: To Design Programmable Automation as per application requirement
CO5: To COMPARE and SELECT Hydarulic Control as per application
CO6: Identify the automation need, type and method for various applications

Course Contents

Unit I	Fundamentals of Industrial Automation	08 Hours

Fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, levels of automation

Unit II	Transfer Line & Automated Assembly	08 Hours

General terminology and analysis, analysis of transfer lines without storage, partial automation. Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines. AS/RS, RFID system

Unit III	Pneumatic Control	08 Hours

Components, constructional details, filter, lubricator, regulator, constructional features, types of cylinders, control valves for direction, pressure and flow, air motors, air hydraulic equipment. Pneumatic Control System Design: General approach to control system design, symbols and drawings, schematic layout, travel step diagram, circuit, control modes, program control, sequence control, cascade method

Unit IV	Programmable Automation	06 Hours

Special design features of CNC systems and features for lathes and machining centers. Drive system for CNC machine tools. Introduction to CIM; condition monitoring of manufacturing systems. Design for high speed automation assembly: Introduction, Design of parts for high speed feeding and orienting, high speed

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automatic insertion. Analysis of an assembly. General rules for product design for automation.

Unit V	Elements of Hydraulic systems	06 Hours

Pumps and motors- types, characteristics. Cylinders, types, typical construction details. Valves for control of direction, flow and pressure, types, typical construction details. Hydraulic System Design: Power pack–elements, design. Pipes material, pipe fittings. Seals and packing. Maintenance of hydraulic systems. Selection criteria for cylinders, valves, pipes. Heat generation in hydraulic system. Advanced topics in Hydraulics and Pneumatics: Electro pneumatics, ladder diagram. Servo and Proportional valves - types, operation, application. Hydro-Mechanical servo systems. PLC- construction, types, operation, programming

Unit VI	Applications of Automation	06 Hours

Case Studies in Industrial Automation, Home Automation, Building Automation, Agricultural Automation, Medical Automation, Smart Cities and other applications, Future of Robotics and Automation

Text Books:

1. Todd D.J., "Fundamentals of Robot Technology", Wiley Publications,
2. Groover M.P., Weiss M., Nagel R.N., Odrey N.G., "Industrial Robotics Technology – Programming and Applications", McGraw Hill Book Co.
3. Fu K.S., Gonzalex R.C., Lee C.S.G., "Robotics Control Sensing, Vision and intelligence", McGraw Hill Book Co.
4. W. Bolton, "Mechatronics", Pearson Education

Reference Books:

1. M.P. Groover, "Industrial Robots – Technology Programmes and Applications", McGraw Hill
2. Heinrich H W, Industrial Accident Prevention, National Safety Council, Chicago
3. Accident Prevention Manual for Industrial Operations, National Safety Council, Chicago.
4. "Personal Protective Equipment", National Safety Council, Bombay.
5. W. Deppert, K.Stoll, "Pneumatic Application"
6. S.F. Krar, "Computer Numerical Control Simplified", Industrial Press, 2001

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Final Year B. Tech. (Automation and Robotics)
Academic Year – 2025-2026 Semester –VII
ARM4201T: Fundamentals of PLC and SCADA
Multi-Disciplinary Minor -IV

Teaching Scheme:	**Credit**	**Examination Scheme: TH**
TH:03 Hours/Week	**TH:03**	**In Sem. Evaluation:20 Marks** **Mid Sem. Exam: 30 Marks** **End Sem. Exam: 50 Marks**

Course Prerequisites: Basics of sensing elements, bridges and basic electronics Course

Course Objective:

1. To understand PLC basics
2. To understand types of PLC inputs and outputs
3. To apply the knowledge of PLC programming instructions
4. To understand SCADA importance in Industry
5. To understand Networking in Industrial Automation
6. To apply the practical applications of PLC programming in Industries

Course Outcome:
After successful completion of the course, students will able to:
CO1: Explain the basics of PLC
CO2: Classify and Explain PLC inputs and outputs
CO3: Implement advanced PLC programming for Industrial usage
CO4: Explain the basics of SCADA
CO5: Demonstrate the Industrial Networking in SCADA
CO6: Apply the knowledge of PLC in Industries

Course Contents

UNIT-I	**Introduction**	**07 Hours**
Introduction, - Need for PLC, PLC evolution, PLC input/output instructions, Development of Relay ladder logic, PLC Configuration, Scan cycle, Capabilities of PLC, Selection criteria for PLC		
UNIT-II	**Programmable Logic Controller**	**07 Hours**
Types of Programming Languages ,Ladder programming for logic gates & Boolean algebra, PLC Wiring-Sourcing and Sinking concepts, PLC input/output instructions		
UNIT-III	**PLC Programming**	**07 Hours**
Types of Programming – Bit Instructions -Timers and counters– PLC arithmetic functions PTO / PWM generation- High Speed Counter – Analog Scaling – Encoder Interfacing- Servo drive control – Stepper Motor Control		
UNIT-IV	**Supervisory Control and Data Acquisition**	**07 Hours**
Introduction, definitions and history of Supervisory Control and Data Acquisition, typical SCADA system Architecture, important definitions HMI, MTU, RTU, communication means, Desirable Properties of SCADA system, advantages, disadvantages and applications of SCADA. SCADA generations (First generation - Monolithic, Second generation - Distributed, Third generation – Networked Architecture Functions and features of SCADA systems, System operating states, SCADA system in critical		

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infrastructure: Petroleum Refining Process, Conventional electric power generation, Water Purification System, Chemical Plant.		
UNIT-V	**Networking in SCADA**	**07 Hours**
PLC Networking- Networking standards & IEEE Standard - Protocols - Field bus - Process bus, Modbus and Ethernet -CAN Open. Case studies of manufacturing automation and Process automation**.**		
UNIT-VI	**Applications of PLC and SCADA**	**07 Hours**
Simple materials handling applications, Automatic control of warehouse door, Automatic lubrication of supplier Conveyor belt, motor control, Automatic car washing machine, Bottle label detection and process control application, Design a SCADA system for Manufacturing plant		

Text Books:

T1. Programmable Logic Controllers: Principles & Applications by John W. Webb, Ronald A. Reis, Prentice Hall of India, 5th ed.

T2. Introduction to Programmable Logic Controllers by Gary Dunning, Delmar Thomson Learning, 3rd ed

T3. Programmable Logic Controllers: Programming methods and applications by John R. Hackworth and Frederick D. Hackworth Jr. Pearson publication

Reference Books:

R1. Programmable Logic Controller by Frank D Petruzella, McGraw-Hill Education, 5th ed.

R2. Programmable Logic Controllers by W. Bolton, Elsevier Newness publication, 4th ed

R3. SCADA by Stuart A. Boyer, ISA 1999.

On-Line resources:

1. https://learn.realpars.com/courses/codesys-1-introduction-to-plc-programming
2. https://onlinecourses.nptel.ac.in/noc21_me67/preview

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Final Year B. Tech. (Automation and Robotics)
Academic Year – 2025-2026 Semester –VII
ARM4201L: Fundamentals of PLC and SCADA Laboratory
Multi-Disciplinary Minor -IV

Teaching Scheme:	Credit	Examination Scheme:
LAB:02 Hours/Week	LAB: 01	ISCE: 30 Marks ESE: 20 Marks Total: 50 Marks

Course Prerequisites: Basics of sensing elements, bridges and basic electronics Course

Course Objective:

1. To understand PLC basics
2. To understand types of PLC inputs and outputs
3. To apply the knowledge of PLC programming instructions
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CO3: Implement advanced PLC programming for Industrial usage
CO4: Explain the basics of SCADA
CO5: Demonstrate the Industrial Networking in SCADA
CO6: Apply the knowledge of PLC in Industries

Lab Contents

Guidelines for Assessment

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- Total marks assigned are 25.
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List of Laboratory Assignments/Experiments

1	PLC Programming on basic logic gates
2	Develop a PLC Program to Detect the standing bottles on the conveyor and pushing falling bottles in tray.
3	Develop a PLC programming for Automation System
4	Implement controlling of Traffic Lights in PLC using Ladder Diagram programming language.
5	Develop PLC Program to Change Preset Value of Counter According to Various Products. A parking plot has total capacity of Cars. Number of empty spots is displayed on the display outside

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	the Parking Plot and which spots are available is to be indicated by LEDs.
6	Implement this in PLC using Ladder Diagram programming language.
7	Develop Logic gates using SCADA software
8	Implement controlling of Traffic Lights using SCADA software
9	Develop Analog and Digital Alarm Lights using SCADA software
10	Develop Historical and Real Time Trends using SCADA software

Text Books:

T1. Programmable Logic Controllers: Principles & Applications by John W. Webb, Ronald A. Reis, Prentice Hall of India, 5th ed.

T2. Introduction to Programmable Logic Controllers by Gary Dunning, Delmar Thomson Learning, 3rd ed

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