Savitribai Phule Pune University, Pune,

Maharashtra, India

सावित्रीबाई फुले पुणे विद्यापीठ

Faculty of Science and Technology

National Education Policy (NEP)-2020 Compliant Curriculum

Second Year Engineering (2024 Pattern) in

Artificial Intelligence and Machine Learning

(With effect from Academic Year 2025-26)

Contents

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Second Year of Engineering (2024 Course)
(With effect from Academic Year 2025-26)
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Preface

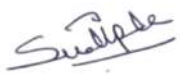
It is with great pride and a deep sense of responsibility that I present the NEP 2020-compliant detailed 2024 pattern curriculum for the **Second Year Bachelor of Engineering in Artificial Intelligence and Machine Learning** at **Savitribai Phule Pune University, Pune**.

In alignment with the visionary framework of the **National Education Policy 2020**, this revised curriculum represents a transformative step towards creating a more holistic, multidisciplinary, and flexible engineering education. The focus is not only on deepening the technical knowledge base of our students, but also on fostering innovation, creativity, ethical thinking, and lifelong learning skills essential in the fast-evolving digital era.

The curriculum for the second year has been thoughtfully structured to strike a balance between core computing fundamentals—such as data structures and algorithms, object-oriented programming, basics of computer network, computer graphics, database management systems, and software engineering—and emerging domains like digital business. In addition, we have integrated value-added courses, skill development modules, interdisciplinary learning components as open electives, and community engagement project to promote practical understanding and industry readiness.

This curriculum is the result of rigorous consultations, deliberations, and collaborative work by esteemed faculty members, industry experts, and academic stakeholders. I extend my heartfelt appreciation to all contributors for their commitment to excellence and innovation in education.

As we implement this forward-looking curriculum, we reaffirm our commitment to nurturing IT professionals who are not only technically sound but also socially responsible and globally competent.



Dr. Sudeep D. Thepade
Chairman, Board of Studies- Information Technology
Savitribai Phule Pune University
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Abbreviations

AEC	Ability Enhancement Course
BSC	Basic Science Course
CCC	Co-Curricular Courses
CCE	Comprehensive Continuous Evaluation
CEP	Common Engineering Project
CO	Course Outcome
ELC	Experiential Learning Courses
ESC	Engineering Science Course
FP	Field Project
IKS	Indian Knowledge System
INT	Internship
MDM	Multidisciplinary Minor
NEP	National Education Policy
OE	Open Elective
OJT	On Job Training
PCC	Program Core Course
PEC	Programme Elective Course
PO	Program Outcomes
PR	Practical
PRJ	Project
PSO	Program Specific Outcome
RM	Research Methodology
TH	Theory
TU	Tutorials
VEC	Value Education Course
VSE	Vocational and Skill Enhancement Course

Savitribai Phule Pune University Second Year Information Technology		
Program Outcomes (POs)		
Learners are expected to know and be able to–		
PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems.
PO2	**Problem analysis**	Identify, formulate, review research literature and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and Engineering sciences.
PO3	**Design / Development of Solutions**	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations.
PO4	**Conduct Investigations of Complex Problems**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern Tool Usage**	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practices.
PO7	**Environment and Sustainability**	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of Engineering practice.
PO9	**Individual and Team Work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication Skills**	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project Management and Finance**	Demonstrate knowledge and understanding of Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments.
PO12	**Life-long Learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO)	
A graduate of the Artificial Intelligence & Machine Learning Program will demonstrate-	
PSO1	An ability to apply the theoretical concepts and practical knowledge of Artificial Intelligence & Machine Learning in analysis, design, development and management of information processing systems and applications in the interdisciplinary domain.
PSO2	An ability to analyze a problem, and identify and define the computing infrastructure and operations requirements appropriate to its solution. AI & ML graduates should be able to work on large-scale computing systems.
PSO3	An understanding of professional, business and business processes, ethical, legal, security and social issues and responsibilities.
PSO4	Practice communication and decision-making skills through the use of appropriate technology and be ready for professional responsibilities

NEP 2020 Compliant Curriculum Structure

Second Year Engineering (2024 Pattern)

Artificial Intelligence and Machine Learning

SEMESTER III

Course Code	Course Title	Type of Course	Teaching Scheme			Examination Scheme						Credit			
			L	T	P	CCE	ESE	TW	PR	OR	Total	L	T	P	Total
PCC-201-AIM	Data Structures & Algorithms	PCC	3			30	70				100	3			3
PCC-202-AIM	Object Oriented Programming	PCC	3			30	70				100	3			3
PCC-203-AIM	Foundation of Artificial Intelligence	PCC	3			30	70				100	3			3
PCC-204-AIM	Data Structures & Algorithms Lab	PCC			4			25	50		75			2	2
PCC-205-AIM	Object Oriented Programming Lab	PCC			2			25		25	50			1	1
	Open Elective I	OEL	2			15	35				50	2			2
MDM-230- AIM	Digital Electronics and Logic Design	MDM	2			30	70				100	2			2
EEM-240- AIM	Principles of Management & Entrepreneurship	EEM		1	2			25			25		1	1	2
VEC-250- AIM	Universal Human Values	VEC	2			15	35				50	2			2
CEF-260- AIM	Community Engagement Project	CEP/FP			4			25		25	50			2	2
Total			15	1	12	150	350	100	50	50	700	15	1	6	22

Note: Students can opt for Open Electives offered by different faculty like Arts, Science, Commerce, Management, Humanities or Inter-Disciplinary studies.

- **Example – Open Elective I - Financial Accounting, Digital Finance, Digital Marketing can be opted from Commerce and Management faculty.**

NEP 2020 Compliant Curriculum Structure

Second Year Engineering (2024 Pattern)

Artificial Intelligence and Machine Learning

SEMESTER IV

Course Code	Course Title	Type of Course	Teaching Scheme			Examination Scheme						Credit			
			L	T	P	CCE	ESE	TW	PR	OR	Total	L	T	P	Total
PCC-206-AIM	Database Management System	PCC	3			30	70				100	3			3
PCC-207-AIM	Foundation of Machine Learning	PCC	3			30	70				100	3			3
PCC-208-AIM	Probability and Statistics	PCC	2			30	70				100	2			2
PCC-209-AIM	Database Management System Lab	PCC			2			25	25		50			1	1
PCC-210-AIM	Foundation of Machine Learning Lab	PCC			2					25	25			1	1
	Open Elective II	OEL	2			15	35				50	2			2
MDM-231- AIM	Internet of Things	MDM	2			30	70				100	2			2
VEC-270- AIM	Digital Marketing and Social Media	VSEC			4			25	25		50			2	2
AEC-281- AIM	Modern Indian Language (Marathi/Hindi)	AEC		1	2			50			50		1	1	2
EEM-241- AIM	E-Commerce	EEM		1	2			25			25		1	1	2
VEC-251- AIM	Environmental Studies	VEC	2			15	35				50	2			2
Total			14	2	12	150	350	125	50	25	700	14	2	6	22

Note: Students can opt for Open Electives offered by different faculty like Arts, Science, Commerce, Management, Humanities or Inter-Disciplinary studies.

- **Example – Open Elective II - Project Management, Business Analytical, Financial Management can be opted from Inter-Disciplinary studies, Commerce and Management faculty respectively.**

General Guidelines

Credit Specifications

I. Theory Courses: 15 hours of teaching per credit is required in a semester.

II. Laboratory Course: 26-30 hours in laboratory activities per credit is required in a semester.

III. Studio activities: Studio activities involve the engagement of students in creative or artistic activities. Every student is engaged in performing a creative activity to obtain a specific outcome. Studio-based activities involve visual- or aesthetic-focused experiential work. A minimum of 26-30 hours in studio activities per credit in a semester is required.

IV. Workshop-based activities: Courses involving workshop-based activities require the engagement of students in hands-on activities related to work/vocation or professional practice. Every student is engaged in performing a skill-based activity. Related to specific learning outcome(s). 26- 30 hours of workshop-based activities per credit in a semester is required.

V. Seminar/ Group Discussion: 13-15 hours of participation in seminar/ Group Discussion activity per credit in a semester is required.

VI. Internship: Credits for internship shall be one credit per two weeks of internship (or 36-40 hours of engagement), The internship shall be monitored jointly by the faculty and Industry/ Organisation Mentor. Internship of One Semester duration shall be offered either in the VII or VIII semesters. Courses offered during the Internship Semester shall be offered in online mode.

VII. Field-based Learning/ Practices: These are the courses requiring students to participate in field-based learning/projects generally under the supervision of faculty. A minimum of 26-30 hours of learning activities per credit in a semester is required.

VIII. Community Engagement Projects: These are the courses requiring students to participate in field-based learning/projects generally under the supervision of faculty. The curricular component of ‘community engagement and service’ will involve activities that would expose students to the socio-economic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems.

26-30 hours of contact time per credit in a semester along with 13-15 hours of activities such as preparation for community engagement and service, preparation of reports, etc., and independent reading and study with 2 credit courses.

Definition of Credit

- 1 hour Lecture (TH) per week per semester = 1 Credit
- 1 hours Tutorial (TU)per week per semester = 1 Credit
- 2 hours Practical (PR)/Laboratory per week = 1 Credit

- 4 Credit theory courses shall be designed for a minimum of 50 hours of the Teaching-Learning process.
- 3 Credit theory courses shall be designed for a minimum of 40 hours of the Teaching-Learning process.
- Two-credit theory courses shall be designed for a minimum of 25 hours of the Teaching-Learning process
- One credit theory course shall be designed for a minimum of 15 hours of the Teaching-Learning process

Guidelines for Examination Scheme

Theory Examination: The theory examination shall be conducted in two different parts Comprehensive Continuous Evaluation (CCE) and End-Semester Examination (ESE).

Comprehensive Continuous Evaluation (CCE):

- CCE of 30 marks based on all the Units of course syllabus to be scheduled and conducted at institute level.

- Case studies included under each unit are intended to support applied learning and are part of Comprehensive Continuous Evaluation

- These case studies will be assessed through internal assessment components such as presentations, assignments, or group discussions. They shall not be included in the End-Semester Theory Examination.

- To design a Comprehensive Continuous Evaluation scheme for a theory subject of 30 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Sr.	Parameters	Marks	Coverage of Units
1	Unit Test	12 Marks	Units 1 & Unit 2 (6 Marks/Unit)
2	Assignments / Case Study	12 Marks	Units 3 & Unit 4 (6 Marks/Unit)
3	Seminar Presentation / Open Book Test/ Quiz	06 Marks	Unit 5

- CCE of 15 marks based on all the Units of course syllabus to be scheduled and conducted at institute level. To design a Comprehensive Continuous Evaluation (CCE) scheme for a theory subject of 15 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Sr. N0.	Parameters	Marks	Coverage of Units
1	Unit Test	10 Marks	Units 1 & Unit 2 (5 Marks/Unit)
2	Seminar Presentation / Open Book Test/ Assignments/Case Studies	05 Marks	Units 3 & Unit 4

Format and Implementation of Comprehensive Continuous Evaluation (CCE)

Unit Test:

- **Format:** Questions designed as per Bloom's Taxonomy guidelines to assess various cognitive levels (Remember, Understand, Apply, Analyze, Evaluate, Create).

- **Implementation:** Schedule the test after completing Units 1 and 2. Ensure the question paper is balanced and covers key concepts and applications.

- **Sample Question Distribution**
  - Remembering (2 Marks): Define key terms related to [Topic from Units 1 and 2].
  - Understanding (2 Marks): Explain the principle of [Concept] in [Context].
  - Applying (2 Marks): Demonstrate how [Concept] can be used in [Scenario].
  - Analyzing (3 Marks): Compare & contrast [Two related concepts] from Units 1 and 2.
  - Evaluating (3 Marks): Evaluate the effectiveness of [Theory/Model] in [Situation].

Assignments / Case Study:
Students should submit one assignment, or one Case Study Report based on Unit 3 and one assignment or one Case Study Report based on Unit 4.

- **Format:** Problem-solving tasks, theoretical questions, practical exercises, or case studies that require in-depth analysis and application of concepts.

- **Implementation:** Distribute the assignments or case study after covering Units 3 & 4.

  Provide clear guidelines and a rubric for evaluation.

Seminar Presentation:

- **Format:** Oral presentation on a topic from Unit 5, followed by a Q&A session.

- **Deliverables:** Presentation slides, a summary report in 2 to 3 pages, and performance during the presentation.

- **Implementation:** Schedule the seminar presentations towards the end of the course. Provide students with ample time to prepare and offer guidance on presentation skills.

Open Book Test:

- **Format:** Analytical and application-based questions to assess depth of understanding.

- **Implementation:** Schedule the open book test towards the end of the course, ensuring it covers critical aspects of Unit 5.

Quiz:

- **Format:** Quizzes can help your students practice existing knowledge while stimulating interest in learning about new topic in that course. You can set your quizzes to be completed individually or in small groups.

- **Implementation:** Online tools and software can be used create quiz. Each quiz is made up of a variety of question types including multiple choice, missing words, true or false etc.

Example Timeline for conducting CCE:

- Weeks 1-4: Cover Units 1 and 2
- Week 5: Conduct Unit Test (12 marks)
- Weeks 6-8: Cover Units 3 and 4
- Week 9: Distribute and collect Assignments / Case Study (12 marks)
- Weeks 10-12: Cover Unit 5
- Week 13: Conduct Seminar Presentations or Open Book Test or Quiz (6 marks)

Evaluation and Feedback:

- **Unit Test:** Evaluate promptly and provide constructive feedback on strengths and areas for improvement.

- **Assignments / Case Study:** Assess the quality of submissions based on the provided rubric. Offer feedback to help students understand their performance.

- **Seminar Presentation:** Evaluate based on content, delivery, and engagement during the Q&A session. Provide feedback on presentation skills and comprehension of the topic.

- **Open Book Test:** Evaluate based on the depth of analysis and application of concepts. Provide feedback on critical thinking and problem-solving skills.

End-Semester Examination (ESE)

End-Semester Examination (ESE) of 70 marks written theory examination based on all the unit of course syllabus scheduled by university. Question papers will be sent by the University through QPD (Question Paper Delivery). University will schedule and conduct ESE at the end of the semester.

Format and Implementation:

- **Question Paper Design:** Below structure is to be followed to design an End-Semester Examination (ESE) for a theory subject of 70 marks on all 5 units of the syllabus with questions set as per Bloom's Taxonomy guidelines and 14 marks allocated per unit.

- **Balanced Coverage:** Ensure balanced coverage of all units with questions that assess different cognitive levels of Bloom's Taxonomy: Remember, Understand, Apply, Analyse, Evaluate, and Create.

  The questions should be structured to cover:
  - Remembering: Basic recall of facts and concepts.
  - Understanding: Explanation of ideas or concepts.
  - Applying: Use of information in new situations.
  - Analysing: Drawing connections among ideas.
  - Evaluating: Justifying a decision or course of action.
  - Creating: Producing new or original work (if applicable).

- **Detailed Scheme:** Unit-Wise Allocation (14 Marks per Unit): Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.

SYLLABUS
SEMESTER - III

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: PCC-201-AIM
Course Name: Data Structures & Algorithms

Teaching Scheme	Credits	Examination Scheme
Theory :3 H/W	3	CCE - 30 Marks End Sem - 70 Marks

Prerequisite Courses, if any: Fundamental knowledge of programming language and basics of algorithms

Companion Course, if any: Discrete Structures/Discrete Mathematics

Course Objectives:

1. To study data structures and their implementations and applications.
2. To understand and apply appropriate data structures to implement stack and queue.
3. Strategically select and apply appropriate data structures and algorithms for effectively solving problems that can be modeled using tree & graph
4. To learn different file organizations.
5. To learn and apply advanced algorithmic techniques such as Divide and Conquer, Greedy Method, and Dynamic Programming for problem solving

Course Outcomes:

1. To Perform basic analysis of algorithms with respect to time and space complexity.
2. To apply appropriate data structures to implement stack and queue.
3. To design and specify the operations of a nonlinear-based abstract data type and implement them in a high-level programming language.
4. Design different hashing functions
5. To Solve real-life optimization problems using Divide and Conquer, Greedy, and Dynamic Programming strategies.

Course Contents

Unit No: I	Introduction to Data Structures & Algorithms	07 Hours

Introduction to Data Structures: Data, Data Object, Data types, Abstract Data Types (ADT), Data structures, Classification of Data Structure: primitive and non-primitive, Static and Dynamic, Persistent and Ephemeral data structures

Introduction to Algorithms: Definition and Characteristics of an algorithm, Algorithm Specification, Introduction to algorithm design strategies

Performance Analysis- Time and space complexity, Asymptotic notations, Best, Average and worst cases. Finding complexity using step count method, Analysis of programming Constructs- Linear, Quadratic, Cubic, Logarithmic

Basic Searching Algorithms: Linear Search, Binary Search
Basic Sorting Algorithm: Bubble Sort, Selection Sort, Insertion Sort

Exemplars /Case Studies	**Case Study 1:** Efficient Data Retrieval in Large Databases **Case Study 2:** Student Attendance Tracker

Unit No: II	**Linear Data Structures**	**07 Hours**
Linked Lists: Singly LL, Doubly LL, Circular LL. Linked list as an ADT. **Stack:** Stack as an ADT, Arrays and Linked Lists implementation, Implicit vs explicit stack, Applications of stack: recursion, converting expressions from infix to postfix or prefix form, evaluating postfix or prefix form **Queue:** Queue as an ADT, Arrays and Linked Lists implementation, Types: Circular Queue, Double-ended Queue (Deque), Applications		
Exemplars/Case Studies	1. **Linked Lists (Doubly LL):** A music player application uses a doubly linked list to store songs in a playlist. Users can navigate forward and backward through the playlist. Each song node contains data about the song and references to both the previous and next songs. 2. **Stack:** Undo/Redo Feature in Text Editors. 3. **Queue:** In a network router, a queue is used to buffer packets for transmission. The packets arrive in order and are transmitted in the same order, ensuring smooth data flow through the network. In a real-time system, a deque could be used to handle urgent tasks at both ends of the queue.	
Unit No: III	**Non- Linear data Structures**	**09 Hours**
Tree-Definitions and Concepts, Representation of binary tree, Binary tree traversal (Inorder, postorder, preorder), Threaded binary tree, Binary search trees, Conversion of General Trees To Binary Trees, Applications Of Trees Some balanced tree mechanism, eg. AVL trees, 2-3 trees, Height Balanced, Weight Balance, **Graph**-Matrix Representation Of Graphs, Elementary Graph operations,(Breadth First Search, Depth First Search, Spanning Trees, Shortest path, Minimal spanning tree- Prims and Kruskals Algorithm) **Heap**: Heap data structure, Min and Max Heap, Heap sort, applications of heap		
Exemplars/Case Studies	1 Recommendation System for E-commerce (tree) 2 Optimizing Product Filtering Performance on a High-Traffic E-commerce Site(tree) 3 “India Airlines" Flight Search Optimization (Graph)	
Unit No: IV	**Hashing, String processing Applications**	**08 Hours**
Hashing: Hash Functions, Collision Handling Techniques (Chaining, Open Addressing) **String Processing**: Naïve String Matching, Rabin-Karp Algorithm, Knuth-Morris-Pratt (KMP) Algorithm **Applications of DSA**: , Social Network Graph Analysis, and AI Search Algorithms		

Exemplars/Case Studies	**Case Studies on File Systems**	
Unit No: V	**Advanced Algorithms**	**07 Hours**

Divide and Conquer: Merge Sort, Quick Sort, Matrix Multiplication;
Greedy Algorithms: Activity Selection, Fractional Knapsack, Huffman Coding;
Dynamic Programming: 0/1 Knapsack, Longest Common Subsequence (LCS), Floyd-Warshall.

Exemplars/Case Studies	**1. Efficient Parcel Sorting in a Warehouse (Concepts**: Merge Sort, Quick Sort) **2. Optimizing Ad Slot Allocation in Online Streaming (Concepts**: Activity Selection, Fractional Knapsack (Greedy)) **Scenario**: Choose the best set of ads to show within a fixed break time to maximize revenue.

Learning Resources

Text Books:

1. Michael T. Goodrich, Roberto Tamassia, and David M. Mount , “Data Structures and Algorithms in C++"
2. R. Gilberg, B. Forouzan, “Data Structure: A Pseudo code approach with C++”, Cengage Learning.

Reference Books:

1. Thomas H. Cormen, Charles E. Leiserson and Ronald L. Rivest, “Introduction to Algorithms”, 2nd Edition, The MIT Press, 2001, ISBN 0-262-03293-7.
2. Sartaj Sahni, “Data Structures, Algorithms and Applications in C++”, 2nd Edition, Universities Press.
3. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C++” (2007), Second Edition, Pearson Education.
4. Goodrich, “Data Structures and Algorithms in C++”, Wiley.

e-Books:

Links to online SWAYAM/NPTEL Courses:

1. NPTEL, “Introduction to Data Structures**”,** By Dr Gurpreet Singh Lehal
2. Link: https://onlinecourses.swayam2.ac.in/cec25_hs62/preview
3. NPTEL, “Data Structures” By Dr. M. Deivamani
4. Link: https://onlinecourses.swayam2.ac.in/cec25_ma15/preview

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: PCC-202-AIM
Course Name: Object Oriented Programming

Teaching Scheme	Credits	Examination Scheme
Theory : 3 Hours/Week	3	CCE- 30 Marks End-Sem- 70 Marks

Prerequisite Courses, if any: **Programming and Problem Solving**

Companion Course, if any: **Principles of Programming Languages**

Course Objectives:

1. To apply the concepts of the object-oriented programming paradigm.
2. To design and implement models for real-life problems using object-oriented programming.
3. To develop effective object-oriented programming skills.

Course Outcomes: On completion of the course, students will be able to–
CO1: Understand OOP concepts like classes, objects, inheritance, and polymorphism.
CO2: Use methods, constructors, and memory management.
CO3: Apply inheritance and polymorphism for code reuse.
CO4: Handle exceptions and use generics with collections.
CO5: Perform file handling and implement basic design patterns.

Course Contents

Unit No: I	Foundations of Object-Oriented Programming	06 Hours

Introduction to OOP:
Limitations of Procedural Programming, Need for Object-Oriented Programming, Fundamentals of Object-Oriented Programming: Objects, Classes, Data Members, Methods, Messages, Data Encapsulation, Data Abstraction and Information Hiding, Inheritance, Polymorphism, Static and Dynamic Binding, Message Passing.
Class: Creating a Class, Visibility/Access Modifiers, Encapsulation.

Exemplars/Case Studies	Model a real world scenario (vehicle class, fruit class, student management in university etc.) using Object Oriented Paradigm
Reference Books	Java: The Complete Reference by Herbert Schildt, Object-Oriented Programming with Java by E. Balagurusamy

Unit No: II	Methods and Constructors	06 Hours

Methods: Adding a Method to a Class, Returning a Value, Adding a Method That Takes Parameters, The this Keyword, Method Overloading, Object Creation, Using Object as a Parameter, Returning Objects, Array of Objects.

Memory Allocation: new, Static Data Members, Static Methods.

Constructors: Introduction, Use of Constructors, Characteristics of Constructors, Types of Constructors, Constructor Overloading.

Garbage Collection: Destructors and Finalizers.

Exemplars/Case Studies	• Represent a vector using class and include appropriate methods to perform various tasks. • A book shop inventory
Reference Books	• Java: The Complete Reference by Herbert Schildt, • Object-Oriented Programming with Java by E. Balagurusamy

Unit No: III	**Inheritance & Polymorphism**	**06 Hours**

Inheritance:
Introduction, Need of Inheritance, Types of Inheritance, Benefits of Inheritance, Cost of Inheritance, Constructors in Derived Classes, Method Overriding, Abstract Classes and Interfaces.
Polymorphism and Software Reuse:
Introduction, Types of Polymorphism, Compile-Time and Run-Time Polymorphism, Mechanisms for Software Reuse, Efficiency and Polymorphism.

Exemplars/Case Studies	• A bank account system
Reference Books	• Java: The Complete Reference by Herbert Schildt, • Object-Oriented Programming with Java by E. Balagurusamy

Unit No: IV	**Exception Handling and Generic Programming**	**06 Hours**

Exception Handling:
Errors, Types of Errors, Exceptions and Their Types, Exception-Handling Fundamentals, Uncaught Exceptions, Using try and catch, Multiple catch Clauses, Nested try Statements, User-Defined Exceptions using throw.

Generics: Introduction, Introduction to Language-Specific Collection Interfaces: List Interface and Set Interface, Collection Classes: ArrayList Class and LinkedList Class.

Exemplars/Case Studies	• Exception handling and generic programming using array list (ArrayList class)
Reference Books	• Java: The Complete Reference by Herbert Schildt,

	• Object-Oriented Programming with Java by E. Balagurusamy

Unit No: V	File Handling and Design Patterns	06 Hours

File Handling: Introduction; Concepts of Streams, Stream Classes, Byte Stream Classes, Character Stream Classes, Using Streams and Other Useful I/O Classes, Using the File Class, Input/output Exceptions, Creation of Files, Reading/Writing Characters, Reading/Writing Bytes, Handling Primitive Data Types, Concatenating and Buffering Files, Random Access Files.

Design Patterns: Introduction, Types of Design Patterns, Adapter, Singleton, Iterator.

Exemplars/Case Studies	• Student Management System
Reference Books	• Java: The Complete Reference by Herbert Schildt, • Object-Oriented Programming with Java by E. Balagurusamy, • Head First Design Patterns by Eric Freeman & Elisabeth Robson, O'Reilly

Learning Resources

Text Books:

1. Java: The Complete Reference by Herbert Schildt, McGraw-Hill
2. Object-Oriented Programming with Java by E. Balagurusamy, McGraw-Hill

Reference Books:

1. Head First Java by Kathy Sierra & Bert Bates, O'Reilly
2. Effective Java by Joshua Bloch, Addison-Wesley
3. Head First Design Patterns by Eric Freeman & Elisabeth Robson, O'Reilly

e-Books:

1. Java: The Complete Reference (PDF/ePub) *(Free e-book platforms)*
2. Head First Java (PDF)
3. Java Programming Tutorials (w3schools)
4. GeeksforGeeks Java Programming

Links to online SWAYAM/NPTEL Courses:

1. **Programming in Java – NPTEL (Prof. Debasis Samanta, IIT Kharagpur)**
   https://onlinecourses.nptel.ac.in/noc23-cs85
2. **Object-Oriented Programming in Java – NPTEL (Prof. D. Parameswaran, IIT Madras)**
   https://onlinecourses.nptel.ac.in/noc22-cs30
3. **Introduction to Programming in Java – SWAYAM**
   https://swayam.gov.in/nd1_noc20_cs35

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: PCC-203-AIM
Course Name: Foundation of Artificial Intelligence

Teaching Scheme	Credits	Examination Scheme
Theory : **3 Hrs**	**3**	CCE -**30 Marks** End-Sem - **70 Marks**

Prerequisite Courses, if any: **1. Discrete Mathematics 2. Programming and Problem Solving**

Companion Course, if any: 1. Data Structures and Algorithms

Course Objectives:

1. To understand Fundamental concepts of Artificial Intelligence and statistical relationship
2. To understand Problem Solving using various peculiar search strategies for AI
3. To solve complex decision problems using adversarial search and logical reasoning.
4. To explore Various knowledge representations and reasoning schemes.
5. To explore various applications of AI

Course Outcomes:

1. Understand the foundational concepts and historical development of Artificial Intelligence
2. Design smart systems using different informed search / uninformed search or heuristic
3. approaches
4. Apply AI techniques to develop intelligent solutions for game playing
5. Apply knowledge reasoning and knowledge representation methods for solving real world problems
6. Illustrate applications of AI in diverse domains.

Course Contents

Unit No: I	**Introduction to AI**	08 Hours

Definition of AI- Understanding AI as an academic discipline, AI vs Human Intelligence. **History of AI-** Timeline and major milestones, Turing Test, and early symbolic AI. **Applications of AI-** AI in healthcare, robotics, finance, education, defense, **Intelligent Agents-** Agent and environment, Rationality, PEAS description (Performance measure, Environment, Actuators, Sensors). Types: Simple Reflex, Model-based, Goal-based, Utility-based. **Properties of Task Environment-** Observable Vs Partially Observable, Deterministic vs Stochastic, Episodic vs Sequential, Static vs Dynamic, Discrete vs Continuous

Exemplars/ Case Studies	AI in Healthcare – Use of AI in COVID-19 Diagnosis and Forecasting. (Explore how AI was utilized to analyze medical images and predict outbreak trends.)
Reference Books	Artificial Intelligence: A Modern Approach, 4th US ed. by Stuart Russell and Peter Norvig

Unit No: II	**Problem Solving based on Searching**	08 Hours

Problem Formulation- State space, initial state, goal state, operators, path cost. **Uninformed Search Strategies-** Breadth-First Search (BFS), Depth-First Search (DFS), Uniform Cost Search, Iterative

Deepening DFS. **Informed (Heuristic) Search-** Heuristic functions (admissibility, consistency), Greedy Best-First Search, A* Search Algorithm. **Performance Metrics-** Completeness, Optimality, Time, and Space complexity		
Exemplars/ Case Studies	A* in GPS Navigation, Airline Crew Scheduling Using Hill Climbing, Example: 8-puzzle, vacuum cleaner	
Reference Books	Artificial Intelligence: A Modern Approach, 4th US ed. by Stuart Russell and Peter Norvig	
Unit No: III	**Constraint Satisfaction Problems and Adversarial Search**	08 Hours
Adversarial Search – Games, The minimax algorithm, Optimal decisions in multiplayer games, Alpha-Beta Pruning, Evaluation functions, Cutting off search, Games with an Element of Chance. Logical Agents – Knowledge-Based agents Constraint satisfaction Problem: Graph Coloring problem, Water Jug Problem		
Exemplars/ Case Studies	1.Study of Computer Othello using Minimax and Alpha Beta Pruning 2.Study of IBM's deep Blue	
Reference Books	Artificial Intelligence: A Modern Approach, 4th US ed. by Stuart Russell and Peter Norvig	
Unit No: IV	**Knowledge Representation And Reasoning**	08 Hours
Introduction to Logic and Reasoning -Propositional Logic-First Order Logic-Inference in First Order Logic- Unification, Forward Chaining, Backward Chaining, Resolution. Quantifying Uncertainty-Bayes Rule -Bayesian Belief Network- Approximate Inference in Bayesian networks		
Exemplars/ Case Studies	Use forward chaining and backward chaining for identifying common illnesses on given symptoms	
Reference Books	Artificial Intelligence: A Modern Approach, 4th US ed. by Stuart Russell and Peter Norvig	
Unit No: V	**AI Applications and Future Trends**	06 Hours
Applications of AI in: Robotics, Natural Language Processing (NLP), Expert Systems, Computer Vision Systems, Autonomous Vehicles. **Emerging Trends**: Explainable AI (XAI) -LIME/SHAP frameworks, Federated Learning, Generative AI & Large Language Models (LLMs) – GPT, BERT, DALL·E, ChatGPT, Prompt Engineering – Crafting effective prompts for LLMs.		
Exemplars/ Case Studies	AI in Autonomous Vehicles – Tesla's Self-Driving Capabilities (Explore perception, decision-making, and ethical dilemmas in autonomous navigation.)	
Reference Books	Artificial Intelligence: A Modern Approach, 4th US ed. by Stuart Russell and Peter Norvig	
Learning Resources		
Textbooks: 1. Artificial Intelligence: A Modern Approach, 4th US ed.by Stuart Russell and Peter Norvig		

2. A First Course in Artificial Intelligence:1st Edition By Deepak Khemani McGrawHill

3. Kothari C.R., "Research Methodology. New Age International, 2004, 2nd Ed; ISBN:13: 978-81-224-1522-3

Reference Books

1. Artificial Intelligence with Python, Prateek Joshi, Packt Publication, ISBN:9781786464392
2. Artificial Intelligence: Structures and Strategies by George Luger.
3. J. Gabriel, Artificial Intelligence: Artificial Intelligence for Humans (Artificial Intelligence, Machine Learning), Create Space Independent Publishing Platform, First edition, 2016

e-Resources

1. https://aima.cs.berkeley.edu/
   Artificial Intelligence: A Modern Approach, 4th US ed.

Links to online SWAYAM/NPTEL Courses

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview
2. https://onlinecourses.nptel.ac.in/noc22_cs56/preview

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: PCC-204-AIM
Course Name: **Data Structures & Algorithms Lab**

Teaching Scheme	Credits	Examination Scheme
Practical : 4 Hrs /wk	2	TW : 25 PR :50

Course Objectives:

1. To study data structures and their implementations and applications.
2. To understand and apply appropriate data structures to implement stack and queue.
3. Strategically select and apply appropriate data structures and algorithms for effectively solving problems that can be modeled using tree & graph
4. To learn different file organizations.
5. To learn and apply advanced algorithmic techniques such as Divide and Conquer, Greedy Method, and Dynamic Programming for problem solving

Course Outcomes:

1. To perform basic analysis of algorithms with respect to time and space complexity.
2. To apply appropriate data structures to implement stack and queue.
3. To design and specify the operations of a nonlinear-based abstract data type and implement them in a high-level programming language.
4. Design different hashing functions
5. To Solve real-life optimization problems using Divide and Conquer, Greedy, and Dynamic Programming strategies.

Guidelines for Instructor's Manual

The faculty member should prepare the laboratory manual for all the experiments and it should be made available to students and laboratory instructor/Assistant.
The instructor's manual should include prologue, university syllabus, conduction & Assessment guidelines, topics under consideration-concept, objectives, outcomes, algorithm written in pseudo language, sample test cases and references. Experiments to be conducted Part A in C++ and Part B in python.

Guidelines for Student's Lab Journal

1. The laboratory assignments are to be submitted by students in the form of journals. The Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software & Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory Concept, algorithms, printouts of the code written using coding standards, sample test cases etc.)
2. Practical Examination will be based on the term work.
3. Candidate is expected to know the theory involved in the experiment.
4. The practical examination should be conducted if the journal of the candidate is completed in all respects and certified by concerned faculty and head of the department.
5. All the assignment mentioned in the syllabus must be conducted.

Guidelines for Lab /TW Assessment

1. Examiners will assess the term work based on performance of students considering the

2. parameters such as timely conduction of practical assignment, methodology adopted for implementation of practical assignment, timely submission of assignment in the form of
3. handwritten write-up along with results of implemented assignment, attendance etc.
4. Examiners will judge the understanding of the practical performed in the examination by asking some questions related to theory & implementation of experiments he/she has carried out.
5. Appropriate knowledge of usage of software and hardware such as compiler, debugger, coding standards, algorithm to be implemented etc. should be checked by the concerned faculty member(s).

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications.
All the assignments should be conducted on multicore hardware and 64-bit open-source software.

Guidelines for Practical Examination

Both internal and external examiners should jointly set problem statements for practical examination. During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement. The supplementary and relevant questions may be asked at the time of evaluation to judge the student‘s understanding of the fundamentals, effective and efficient implementation. The evaluation should be done by both external and internal examiners.

List of Assignments

Virtual Laboratory

· https://ds1-iiith.vlabs.ac.in/data-structures-1/
· https://ds2-iiith.vlabs.ac.in/data-structures-2/
· http://cse01-iiith.vlabs.ac.in/

PART A (Using C++)

1. Searching and Sorting -- CO1, CO2

Design a program to maintain a student database that performs the following tasks:

1. Add and store student details (ID, Name, CGPA) using dynamically allocated memory.
2. Expand the student list using realloc() as new entries are added.
3. Implement Linear Search and Binary Search to find student records by ID.
4. Implement at least two Sorting Algorithms (Bubble Sort, Selection Sort, or Insertion Sort) to sort
   student records by:
   a. Name (Alphabetically)
   b. CGPA (Ascending/Descending)
5. Analyze and compare the performance of search operations before and after sorting.

2. Stack : CO1, CO2

Implement stack as an abstract data type using singly linked list and use this ADT for conversion of infix expression to postfix, prefix

3. Circular Queue -- CO1, CO2

Implement Circular Queue using Array. Perform following operations on it.

a. Insertion (Enqueue)
b. Deletion (Dequeue)
c. Display

(Note: Handle queue full condition by considering a fixed size of a queue.)

PART B (Using Python)

4. Binary Search Tree -- CO1, CO2, CO3

Implement binary search tree and perform following operations:

a. Insert (Handle insertion of duplicate entry)
b. Delete
c. Search
d. Display tree (Traversal)
e. Display - Depth of tree
f. Display - Mirror image
g. Create a copy
h. Display all parent nodes with their child nodes
i. Display leaf nodes
j. Display tree level wise

5. Graph: Minimum Spanning Tree -- CO1, CO2, CO3

Represent a graph of your college campus using adjacency list /adjacency matrix. Nodes should represent the various departments/institutes and links should represent the distance between them.

Find minimum spanning tree

a. Using Kruskal's algorithm.
b. Using Prim's algorithm.

6. Heap Sort -- CO1, CO2, CO4

Design and implement the Heap Sort algorithm to efficiently sort an array of integers in ascending order. The implementation should be optimized for time and space complexity and should clearly demonstrate the working principles of heap data structures (min-heap or max-heap as applicable)

7. Divide and Conquer (Merge Sort) - CO1, CO2, CO5

Sort Online Orders by Delivery Time using Merge Sort.
Problem Statement: You are given a list of online orders, each with an estimated delivery time in minutes. Write a program to sort these orders using the Merge Sort algorithm so the delivery system can prioritize quicker deliveries first.

8. Greedy Algorithm (Fractional Knapsack) - CO1, CO2, CO5

Maximize Profit by Shipping Partial Orders (Fractional Knapsack)
Problem Statement: You run a shipping company and need to load a truck with parcels of different weights and profits. The truck has a limited weight capacity. Write a program to choose parcels (even partially) to maximize profit using the Fractional Knapsack strategy.

9. String Processing: Naïve String Matching - CO1, CO2, CO4

Given:

l A text string text of length n.

l A pattern string pattern of length m.

Objective:

Find all starting indices i in the text such that the substring text[i:i+m] is exactly equal to the

pattern pattern, using the Naive String Matching Algorithm approach.

Constraints:

l $0 \leq m \leq n$

l Characters in text and pattern can be any valid characters (e.g., a–z, A–Z, digits, etc.)

10. AI search Algorithm -CO1, CO2, CO4, CO5

To design and implement a maze navigation system that enables an agent to find an optimal path from a starting point to a goal using AI search algorithms. The system should be capable of solving both static and dynamic mazes and should visualize the pathfinding process.

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: PCC-205-AIM
Course Name: Object Oriented Programming Lab

Teaching Scheme	Credits	Examination Scheme
Practical : 2 Hrs/wk	**1**	**TW : 25** **OR :25**

Prerequisite Courses, if any: Good understanding of Programming and Problem-Solving concepts

Course Objectives:

1. To understand principles of object-oriented programming (OOP).
2. To understand role of Object-oriented paradigm in program design.
3. To demonstrate Object-oriented programming concepts using Java Programming language

Course Outcomes: Upon successful completion of this course, students will be able to:

CO1: Apply fundamental constructs like control statements, for implementing an application.

CO2: Implement java programs using, class, objects, constructors in Java, arrays, managing I/O

CO3: Apply object-oriented features like Inheritance, Polymorphism, Dynamic binding for implementing an application.

CO4: Apply concepts of exception handling, multi-threading for implementing an application.

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/ preface etc.), University syllabus, conduction & Assessment guidelines, topics under consideration concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Lab Journal

1. The laboratory assignments are to be submitted by student in the form of journal.
2. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software & Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- OOP feature/Concept in brief, algorithm, flowchart, test cases, conclusion/analysis.
3. Program codes with sample output of all performed assignments are to be submitted as hardcopy.
4. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided.
5. Use of DVD containing students programs maintained by lab In-charge is highly encouraged.
6. For reference one or two journals may be maintained with program prints at Laboratory.

Guidelines for Lab /TW Assessment

1. Continuous assessment of laboratory work is done based on overall performance and lab assignments performance of student.
2. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage.
3. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness.

Guidelines for Oral Examination

1. **Internal and external examiners** should jointly prepare oral questions based on the syllabus.
2. During the oral assessment, the examiner should focus on:
   a. The student's **ability to explain the implemented code** and underlying logic.
   b. **Understanding of core concepts** like classes, inheritance, polymorphism, and exception handling.
   c. Answering **supplementary questions** to assess advanced learning and application of concepts.
3. The student should demonstrate **clear communication** and **effective problem-solving skills**.

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments without changing its complexity level and distribute among batches of students. Encourage students for the use of industry coding standards such as appropriate use of Hungarian notation, Indentation and comments. Use of open-source software is encouraged. Set of suggested assignment list is provided, instructors may take different case studies with similar complexity level. Operating System recommended: - 64-bit Open-source Linux or its derivative Programming tools recommended: - JAVA IDE

List of Assignments

1. **Classes and Object-** CO1, CO2

Design a class Complex with data members for real and imaginary parts. Provide default and parameterized constructors. Write a program to perform arithmetic operations on two complex numbers.

2. **Polymorphism-** CO1, CO3

Identify commonalities and differences between Publication, Book, and Magazine classes. Use title, price, and copies as common attributes and saleCopy() as a common method. Include author, orderCopies() in Book, and orderQty, currentIssue, receiveIssue() in Magazine. Write a program to order book copies and display total publication sales.

3. **Inheritance -** CO1, CO3

Design an inheritance hierarchy for an employee payroll system. Create an Employee class with fields like Emp_name, Emp_id, Address, Mail_id, and Mobile_no. Inherit Programmer, Team Lead, Assistant Project Manager, and Project Manager from it. Add Basic Pay and calculate DA (97%), HRA (10%), PF (12%), and Staff Club Fund (0.1%) for salary slip generation.

4. **Dynamic Binding -** CO1, CO3

Design a base class Shape with double-type values and a method compute_area(). Derive Triangle and Rectangle classes from it. Make compute_area() abstract and override it in derived classes. Use dynamic binding to calculate and display the area based on user input.

5. **Interface -** CO1, CO3

Implement an interface for vehicles with methods like gearChange(), speedUp(), and applyBrakes(). Create classes Bicycle, Car, and Bike implementing these functionalities in their own way.

6. **Exception Handling -** CO4

Create a program to handle ArithmeticException, ArrayIndexOutOfBoundsException, and NumberFormatException. The user enters two numbers, and their division is shown. Handle invalid inputs and division by zero.

7. **Template (Generics) -** CO4

Write a generic program using a collection class to count elements with specific properties such as even, odd, prime numbers, or palindromes.

8. **File Handling -** CO5

Implement a student record database using files with the following operations:

a. Create Database
b. Display Database
c. Delete Record
d. Update Record
e. Search Record

Each student has Student_id, Name, Roll_no, Class, Marks, and Address.

Text Books:

1. **Java: The Complete Reference** by Herbert Schildt, McGraw-Hill
2. **Object-Oriented Programming with Java** by E. Balagurusamy, McGraw-Hill

Reference Books:

1. Core Java Volume I – Fundamentals by Cay S. Horstmann
2. Effective Java by Joshua Bloch

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: MDM-230-AIM
Course Name: Digital Electronics and Logic Design

Teaching Scheme	Credits	Examination Scheme:
Theory :2 Hrs/wk	2	CCE:30 Marks ESE:70 Marks

Prerequisite Courses, if any: Basics of Electronics Engineering

Companion Course, if any:

Course Objectives:
1. To learn and understand basic digital design techniques.
2. To develop design and implementation skills of combinational and sequential Logic circuits.
3. To introduce Computer organization and Computer Architecture.

Course Outcomes:
On completion of the course, students will be able to–
CO1: Perform Binary Arithmetic and Logical Operations and code conversions
CO2: Design and Implement Combinational Circuits.
CO3: Differentiate combinational and sequential circuits and use flip flops for various applications
CO4: Design and Implement Sequential Circuits.
CO5: Explain Organization and Architecture of Computer systems

Course Contents

Unit No: I	**Introduction To Digital Electronics**	**06 Hours**

Digital Logic families: Digital IC Characteristics; TTL: Standard TTL characteristics, Operation of TTL NAND gate; CMOS: Standard CMOS characteristics, operation of CMOS NAND gate; Comparison of TTL & CMOS.
Signed Binary number representation and Arithmetic: Sign Magnitude, 1's complement & 2's complement representation, unsigned Binary arithmetic (addition, subtraction, multiplication, and division), subtraction using 2's complement; IEEE Standard 754 Floating point number representations.
Codes: Binary , BCD, octal, hexadecimal, Excess-3 , Gray code & their conversions

Exemplars/Case Studies	CMOS 4000 series ICs 2) Practical applications of various codes in computers
Reference Books	1. Modern Digital Electronics", R.P. Jain, Tata McGraw-Hill, Third Edition

Unit No: II	**Combinational Logic Design**	**06 Hours**

Logic minimization: Representation of truth-table, SOP form, POS form, Simplification of logical functions, Minimization of SOP and POS forms, don't care Conditions.
Reduction techniques: K-Maps up to 4 variables
CLC design using SSI chips – Code converters, Half- Adder, Full Adder, Half Subtractor, Full Subtractor, n bit Binary adder
Introduction to MSI functions & chips - Multiplexers (IC 74151 and IC 74153), Decoder / Demultiplexer (IC 74138), Binary adder (IC 7483).
Design using MSI chips: BCD adder using IC 7483, Implementation of logic functions using IC 74153, IC 74151 & 74138.

Exemplars/Case Studies	Quine–McCluskey Minimization Technique, Encoder (IC 74147), BCD to 7 segment decoder driver (IC 7447)
Reference Books	1. Modern Digital Electronics", R.P. Jain, Tata McGraw-Hill, Third Edition

Unit No: III	**Flip Flops and their Applications**	**06 Hours**

Introduction to sequential circuits. Difference between combinational circuits and sequential circuits, memory element – latch.
Flip- Flops: Design, truth table, excitation table of SR, JK, D, T flip flops. Study of flip flops with asynchronous and synchronous Preset & Clear, Master Slave configuration, conversion from one type to another type of flip flop. Study of flip flop ICs - 7473, 7474, 7476
Application of flip-flops – Bounce elimination switch, Counters- asynchronous, synchronous and modulo counters, Study of modulus n counter ICs- 7490 & their applications to implement mod counters

Exemplars/Case Studies	Simple Traffic Light controller
Reference Books	1. Modern Digital Electronics", R.P. Jain, Tata McGraw-Hill, Third Edition

Unit No: IV	**Introduction to Computer Architecture Sequential Logic Design**	**06 Hours**

Registers- Buffer register, shift register types - SISO, SIPO, PISO & PIPO, applications of shift registers - ring counter, twisted ring counter
Basic design steps-State diagram, State table, State reduction, State assignment, Mealy and Moore machines representation
Sequence generators using counters & sequence detector using Moore & Mealy model

Exemplars/Case Studies	Electronic Voting Machine (EVM)
Reference Books	1. Modern Digital Electronics", R.P. Jain, Tata McGraw-Hill, Third Edition

Unit No: V	**Introduction to Computer Architecture**	**06 Hours**

Computer organization & computer architecture, organization, functions & types of computer units- CPU(typical organization ,Functions , Types), Memory (Types & their uses in computer), IO(types & functions) & system bus(Address, data & control , Typical control lines, Multiple-Bus Hierarchies); Von Neumann & Harvard architecture; Instruction cycle state diagram
Von Neumann Machine: Structure of IAS computer, Registers: PC,MAR,MBR,IR,AC,MQ,IBR and their roles
Control unit : Control signals & typical organization of hard wired & micro programmed Control Unit.

Exemplars/Case Studies	8086 Architecture
Reference Books	1. Computer organization and architecture, designing for performance" by William Stallings, Prentice Hall, Eighth edition

Learning Resources

Text Books

1. “Modern Digital Electronics”, R.P. Jain, Tata McGraw-Hill, Third Edition
2. 2. “Computer organization and architecture, designing for performance” by William Stallings , Prentice Hall ,Eighth edition

Reference Books

1. “Digital Design”, M Morris Mano, Prentice Hall, Third Edition
2. “Computer organization” , Hamacher and Zaky, Fifth Edition
3. “Computer Organization and Design: The Hardware Software Interface” D. Patterson, J. Hennessy, Fourth Edition, Morgan Kaufmann
4. “Microprocessors and interfacing-programming and hardware” Douglas V. Hall and SSSP Rao, McGraw-Hill ,Third Edition

e-Books

Links to online SWAYAM/NPTEL Courses
https://onlinecourses.nptel.ac.in/noc24_ee17/preview
https://onlinecourses.nptel.ac.in/noc25_ee20/preview

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: EEM-240-AIM
Course Name: Principles of Management & Entrepreneurship

Teaching Scheme	Credits	Examination Scheme
Tutorial : 1 hr/wk	1	TW - 25 Marks
Practical : 2 hrs/wk	1	

Prerequisite Courses, if any: None

Companion Course, if any: None

Course Objectives: The objectives of this course are:

1. To explain fundamental management functions and the planning/decision-making process.
2. To describe organizational structure, staffing, and leadership.
3. To demonstrate understanding of motivation and control systems in management.
4. To explain entrepreneurship and the entrepreneurship development process.
5. To illustrate small-scale industries, supporting agencies, and financing for entrepreneurs.
6. To summarize project report preparation and industrial ownership structures

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

CO1: Articulate core management functions, planning, and decision-making.

CO2: Analyze organizational structure, staffing, and leadership in tech teams.

CO3: Explain motivation and control systems in management.

CO4: Demonstrate understanding of entrepreneurship and its development.

CO5: Evaluate small-scale industries, support agencies, project reporting, and industrial ownership.

Course Contents For Tutorial

Unit No: I	Management and Planning Fundamentals	03 Hours

Definition, nature, and characteristics of management, Scope and functional areas, Management as art, science, and profession, Management vs. administration, Roles and levels of management, Development of management thought (classical to modern), Planning: nature, importance, objectives, types (meaning only), Decision-making and planning process, planning hierarchy

Exemplars/Case Studies	***Google**'s adoption of OKRs for strategic planning and innovation alignment.*
Reference Books	1. Robbins & Coulter, "Management", Pearson Lumen Learning: Principles of Management

Unit No: II	Organizing, Staffing, Directing, and Controlling	03 Hours

Organization: nature, purpose, principles, types, departmentation, committees, Centralization vs. decentralization; span of control, MBO & MBE, Staffing: process of selection and recruitment, directing: leadership styles, motivation theories, communication, coordination (meaning, importance, techniques), Controlling: steps,

essentials, methods		
Exemplars/Case Studies	***Netflix**'s team structure and leadership approach for creative project management.*	
Reference Books	1. Northouse, "Leadership: Theory and Practice", SAGE 2. Robbins & Coulter, "Management", Pearson	
Unit No: III	**Entrepreneurship and Entrepreneurial Development**	**03 Hours**
Entrepreneur: meaning, evolution, functions, types, emerging class, Concept and stages of entrepreneurship, Role of entrepreneurs in economic development, Entrepreneurship in India; barriers to entrepreneurship		
Exemplars/Case Studies	*The journey of **Freshworks** from a startup to a global SaaS provider*	
Reference Books	S.S. Khanka, "Entrepreneurial Development", S. Chand Ries, "The Lean Startup", Crown Business	
Unit No: IV	**Small Scale Industries and Institutional Support**	**03 Hours**
SSI: definition, characteristics, objectives, scope, role in economic development, Steps to start an SSI; government policy and support, Impact of liberalization, privatization, globalization, WTO/GATT on SSI, Supporting agencies: TECKSOK, KIADB, KSSIDC, KSIMC, DIC, SISI, NSIC, SIDBI, KSFC, Single Window Agency		
Exemplars/Case Studies	***Zoho**'s growth as a bootstrapped Indian small-scale software company.*	
Reference Books	Vasant Desai, "Small Scale Industries and Entrepreneurship", Himalaya Government of India MSME Portal	
Unit No: V	**Project Preparation and Industrial Ownership**	**03 Hours**
Project: meaning, identification, selection, report preparation (need, significance, contents, formulation, errors), Guidelines by Planning Commission, network analysis, project appraisal, Feasibility studies: market, technical, financial, social, Industrial ownership: partnership (definition, characteristics, types, agreement, registration, rights/duties, advantages/disadvantages), sole proprietorship (features, scope, pros/cons)		
Exemplars/Case Studies	***Razorpay**'s project report and funding journey in the Indian fintech ecosystem.*	
Reference Books	1. Prasanna Chandra, "Projects: Planning, Analysis, Selection, Financing, Implementation, and Review", McGraw Hill 2. Metrick & Yasuda, "Venture Capital and the Finance of Innovation", Wiley	

Learning Resources

Text Books

1. Gupta, R. N. (2014). *Principles of Management*. New Delhi: S. Chand & Sons. ISBN: 9788121924580
2. Prasad, L. M. (2019). *Principles and Practice of Management* (9th ed.). New Delhi: Sultan Chand & Sons. ISBN: 81-979992-1-5

3. Khanka, S. S. (2013). *Entrepreneurial Development* (4th ed.). New Delhi: S. Chand & Company Ltd.
4. McGraw Hill Education. (2020). *Principles of Management*. New Delhi: McGraw Hill.

Reference Books

1. Robbins, S. P., & Coulter, M. (2022). *Management* (15th ed.). Pearson Education.
2. Bateman, T. S., & Snell, S. A. (2017). *Management: Leading & Collaborating in a Competitive World* (13th ed.). New York: McGraw Hill Education.
3. King'ori Ndegwa, A., & Linyiru, B. M. (2021). *Principles of Entrepreneurship and Project Management*. CARI Journals.
4. Walnut Publication. (2020). *A Textbook on Principles and Practices of Entrepreneurship*. Walnut Publication.

e-Books

1. Open Textbook Library. (2017). *Principles of Management*. https://open.umn.edu/opentextbooks/textbooks/693
2. Saylor Academy. (2020). *Principles of Management: Entrepreneurship*. https://learn.saylor.org/mod/book/view.php?id=60507&chapterid=48240

Links to online SWAYAM/NPTEL Courses

1. Entrepreneurship By Prof. C Bhaktavatsala Rao | IIT Madras
2. https://onlinecourses.nptel.ac.in/noc20_mg35/preview
3. Entrepreneurship Management by By Sujit Mukherjee | Maulana Abul Kalam Azad University of Technology https://onlinecourses.swayam2.ac.in/cec24_mg28/preview
4. Entrepreneurship Essentials By Prof. Manoj Kumar Mondal | IIT Kharagpur https://onlinecourses.nptel.ac.in/noc25_ge11/preview
5. NOC:Principles of Management, IIT Roorkee by Prof. Usha Lenka https://nptel.ac.in/courses/110107150

List of Assignments:

Assignment 1

Title: Entrepreneurial Mindset Reflection

Objective:

To encourage students to explore their personal views on entrepreneurship and recognize the key characteristics of an entrepreneurial mindset by studying the journey of a real-world entrepreneur.

Task Description:

Write a reflective essay (500–600 words) addressing the following:

Explain what entrepreneurship means to you personally.

Identify an entrepreneur (Indian or global) whom you admire and explain the reasons for your admiration.

Highlight specific mindset traits (e.g., risk-taking, resilience, innovation, adaptability) that contributed to this entrepreneur's success.

Reflect on how these traits align with your own strengths or indicate areas you wish to develop

Assignment 2

Title: Idea Generation Challenge

Objective:

To foster creativity, structured brainstorming, and the ability to identify potential business opportunities based on real-world problems.

Task Description:

1. Generate Business Ideas using any structured brainstorming technique (e.g., mind mapping, SCAMPER). Ideas can be tech-based, social impact, service-based, or product-based.
2. Select one idea that you find most promising.
3. Write a 1-page Concept Summary, including:
   Problem Identified
   Solution Overview
   Target Audience
   Market Potential

Assignment 3

Title: Organizational Structure Design
Objective:
To understand organizational hierarchy and reporting relationships in a tech startup.
Task Description:
- Draw an organogram for a hypothetical AI/ML startup, labelling key departments and reporting lines.
- Write a 200-word explanation justifying your structure and its suitability for innovation and agility.

Assignment 4

Title: Recruitment Process Simulation
Objective:
To explore staffing and selection processes in a technology context.
Task Description:
- Design a recruitment workflow for hiring an AIML engineer.
- Include job description, sourcing channels, selection criteria, and interview stages.
- Present as a flowchart and provide a brief explanation (150–200 words).

Assignment 5

Title: Small Scale Industry Setup Plan
Objective:
To plan the launch of a small-scale AI/ML business, considering regulatory and operational steps.
Task Description:
Outline the steps to register and launch a small-scale AI/ML business in India, including compliance, funding options, and government support schemes.
Present as a checklist with brief explanations for each step.

Assignment 6

Title: Competitive Analysis Report – Know Your Rivals
Objective:
To develop strategic thinking by analysing competitors and identifying market positioning opportunities.
Task Description:
Competitor Profile: Select 2–3 existing companies/startups that offer similar products/services to your business idea. Describe each competitor's strengths, weaknesses, target customers, and unique selling points. (300–350 words)
Comparison Matrix: Create a side-by-side matrix comparing your business with the chosen competitors in terms of features, pricing, brand presence, and customer

experience.
Opportunity Gap: Conclude with a 200-word write-up on how your idea fills a market gap or offers a superior value proposition.

Assignment 7

Title: Mapping Institutional Support
Objective:
To identify and evaluate support agencies for tech entrepreneurs in India.
Task Description:
Create a table listing at least five Indian agencies (e.g., SIDBI, NSIC, DIC) supporting startups.
For each, summarize their services, eligibility, and application process in 3–4 sentences.

Assignment 8

Title: Project Report Drafting
Objective:
To practice project planning and reporting for a tech venture.
Task Description:
Prepare a mini project report for a proposed AI/ML solution, including project objectives, feasibility studies (market, technical, financial, social), and a basic network diagram.
The report should be 3–4 pages.

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: VEC-250-AIM
Course Name: Universal Human Values

Teaching Scheme	Credits	Examination Scheme
Theory : 2 Hrs./Week	2	CCE - 15 ESE - 35

Prerequisite Courses, if any: --

Companion Course, if any: --

Course Objectives:

1. To help students understand the need, basic guidelines, content and process for value education.
2. To enable students to understand harmony in the human being, family, society, and nature.
3. To develop an understanding of the holistic perception of harmony at all levels of existence.
4. To facilitate students in applying these understandings to live a fulfilling and responsible life.

Course Outcomes: At the end of the course, students will be able to: After completing this course, the students will be able to:

CO1: Understand the significance of universal human values and ethical human conduct.

CO2: Apply the concepts of harmony in self and relationships in real-life scenarios.

CO3: Evaluate the interconnection between individual, society, and nature from a holistic perspective.

CO4: Develop commitment to self-exploration, self-regulation, and social responsibility.

Course Contents

Unit I	**Introduction to Value Education and Harmony in the Human Being**	07 Hrs

Need, Basic Guidelines, and Content of Value Education

Self-exploration: What is it? – Its content and process

The Basic Human Aspirations – Continuous Happiness and Prosperity

Understanding the Human Being as a Co-existence of Self ('I') and Body

Harmony of Self with the Body: Sanyam and Health

Activities of the Self and the Body – Understanding the needs of Self and Body

Unit II	**Harmony in Family and Society**	07 Hrs

Harmony in the Family – Trust and Respect as the Foundation

Nine Universal Values in Relationships

Justice and Responsibility in Human Conduct

Harmony in the Society – Resolution, Prosperity, Fearlessness, and Co-existence

Four Orders of Nature – Self, Material Order, Plant/Bio Order, Animal Order

Unit III	Harmony in Nature and Existence	08 Hrs

Understanding Harmony in Nature – Interconnectedness and Mutual Fulfillment

Holistic Perception of Harmony: Existence as Co-existence

Natural Acceptance and Self-regulation as a Way of Life

Cyclicity in Nature and Responsibility of Human Being

Implications of Imbalance in Nature: Environmental and Societal Consequences

Unit IV	Professional Ethics and Application of Values	08 Hrs

Competence in Professional Ethics: Ability to Utilize Values in Decision-Making

Ethical Human Conduct – The Foundation of Universal Human Order

Vision for a Value-Based Society

Case Studies: Ethical Dilemmas in the IT Sector

Integration of Human Values with Technical Education

Learning Resources

Text Books

1. AICTE Model Curriculum for Universal Human Values
2. Gaur, R. R., Sangal, R., and Bagaria, G. P. Human Values and Professional Ethics 3rd revised ed., PHI, Excel Books Pvt. Ltd., New Delhi, 2010.
3. "Human Values" – M. Govindrajran, S. Natrajan, V.S. Senthil Kumar (PHI Learning)
4. "Professional Ethics and Human Values" – R.S. Naagarazan (New Age International)

Websites and Online Resources

1. https://uhv.org.in/

Links to online SWAYAM/NPTEL Courses

1. Exploring Human Values: Visions of Happiness and Perfect Society (https://nptel.ac.in/courses/109104068)
2. Moral Thinking: An Introduction to Values and Ethics (https://onlinecourses.nptel.ac.in/noc24_hs169/preview)
3. **NPTEL Course: "Human Values and Ethics" by Prof. V. S. Ravi**
   Link: NPTEL - Human Values and Ethics
4. **NPTEL Course: "Human Values" by Prof. R.R. Gaur (IIT Kanpur)**
   Link: NPTEL - Human Values
5. **Value Education Workshop Videos by AICTE/UGC**
   Link: https://www.aiCTE-india.org > Education > Universal Human Values
6. **UGC Video Resources for Human Values**
   Search: "UGC Human Values Video Lectures" on YouTube or SWAYAM

Guidelines for Continuous Assessment – 15 Marks

Objective: Encourage student engagement, self-exploration, reflection, and participation in class discussions and activities.

Suggested Components:

Component	Description	Marks
1. Reflective Journal/Assignments	Weekly personal reflections on class topics, including self-exploration exercises, case study responses, or social observations.	5
2. Group Discussion/Presentation	Active participation in value-based group discussions or presentations (e.g., harmony in family, sustainable living, ethical dilemmas in IT, etc.).	3
3. Class Attendance & Participation	Regular attendance with meaningful classroom interaction.	2
4. Practical/Field Activity	Short practical task: e.g., interviewing family members, conducting a group activity, or community service reflection.	3
5. Viva Voce / Open Book Oral Exam	Brief oral discussion to assess personal understanding of core concepts.	2

Note: Faculty can customize the weightage slightly to suit the nature of class activities or institute policy.

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: CEF-260- AIM
Course Name: Community Engagement Project

Teaching Scheme	Credits	Examination Scheme
Practical: 4 H/w	2	Term Work – 25 Marks ORAL – 25 Marks

Prerequisite Courses, if any:
Students should have a familiarity with problem-solving methodologies and project planning, Basic programming knowledge is essential

Course Objectives:
The objective of this course is to provide students with
1. To identify and analyze environmental issues faced by local communities.
2. To identify the use of technology for societal needs.
3. To design and implement innovative solutions using computer engineering principles to address identified problems.
4. To work in a team with individual contributions to the project development.

Course Outcomes:
After successful completion of the course, Students will be able to :
1. Apply their engineering knowledge to analyze communities' need based on real-world environmental problems.
2. Design real-world applications by considering suitable requirements.
3. Implement real-world applications using suitable tools and technology.
4. Work in a team with individual contributions to the development of the project.
5. Communicate and demonstrate technical information effectively through project reports, presentations, and interactions with community members and mentors.

Course Guidelines for Implementation

1. The purpose of this course is to empower students with the knowledge, skills, and mindset needed to leverage technology for addressing environmental and societal needs.
2. Through a hands-on approach, students will learn to identify, analyze, and solve environmental issues faced by local communities using computer engineering principles.
3. By designing and implementing innovative solutions, students will not only gain technical proficiency but also develop teamwork, collaboration, and communication skills essential for making a positive impact on communities and the environment.

Team Formation, Guide Allocation, and Project Identification:
1. 3-4 students can form a team within the same or different disciplines.
2. Students are expected to explore and understand environmental challenges that communities face, such as pollution, waste management, water scarcity, resource depletion, climate change, energy transition, natural disasters, biodiversity loss, land degradation, etc.
3. The project coordinator, in consultation with a panel of experts, assigns project guides from the same program to provide guidance and support to the teams throughout the project.
4. The identified problem statement addressing environmental challenges must be registered with the project coordinator by the team after consulting with their respective project guide.
5. Field visits are encouraged to identify the problem statements. Collaborative Work and Progress Reporting:

6. Each student on the team must work collaboratively and contribute significantly to the design and development of solutions for registered problem statements, focusing on environmental challenges faced by the community.
7. Students should work at least 4 hours per week and shall meet their assigned project guide regularly (at least twice a week) and report the progress of the project work, emphasizing the application of community engineering principles.
8. Students are expected to Incorporate suggestions from the earlier review.

Documentation and Reporting:

1. Students shall maintain a record of all meetings, remarks given by the guide/reviewers, and progress of the work in the project diary, presented during each review presentation.
2. For the final assessment, students shall complete the project report in all aspects, including formatting, duly signed by the project guide, Head of the Department.

Data Submission and Additional Outputs:

1. Students shall submit all data related to project work in soft copy to their guides, including the project report, A3 size poster, presentation, paper, etc., focusing on community engineering solutions.
    a. Students' groups can conduct an awareness programme on Health and Hygiene or in Organic Farming or in Fisheries, about renewable energy, e-waste OR their selected project topic
2. Oral Examination shall consist of presentation and demonstration of the project work carried out by the project groups.

Mode of Evaluation:

Review I - Problem Identification: (Mid Semester) (Weightage: 50%)

a. Students must identify a specific problem statement related to community engineering projects.
b. The problem statement should be relevant to environmental science/study-related societal needs and address a real-world issue.
c. A brief presentation outlining the identified problem and its significance should be submitted. The presentation should include the background of the problem, literature review, proposed solution approach, and initial findings or developments.
d. Students should be prepared to present their progress to a review committee.

Review II - (Weightage: 50%) (at the end of semester) Solution Development:

a. Projects will be evaluated based on the effectiveness of the solution designed and developed using fabrication, coding, modeling, product design, process design, or other relevant processes for identified problem statement. Outcome Evaluation:
b. The project outcome will be assessed regarding its technical feasibility, economic viability, societal impact, and environmental sustainability.
c. A detailed report covering the problem identification, literature review, methodology, progress made, challenges faced, and future plan should be submitted.
d. ● Teams must prepare an e-document, uploaded along with a plagiarism check report, detailing their project work and findings.
e. ● Each team member must submit their report, highlighting their individual contributions with a brief abstract of the total work in the initial part of the document. Reports must be unique, and the review will be based on individual contributions.

Learning Resources:

Reference Book:

1. Waterman, A. Service-Learning: A Guide to Planning, Implementing, and Assessing Student Projects. Routledge, 1997.
2. Beckman, M., and Long, J. F. Community-Based Research: Teaching for Community Impact. Stylus Publishing, 2016.
3. Design Thinking for Social Innovation. IDEO Press, 2015.
4. Dostilio, L. D., et al. The Community Engagement Professional's Guidebook: A Companion to The Community Engagement Professional in Higher Education. Stylus Publishing, 2017

Web Links

1. UNESCO: Education for Sustainable Development https://www.unesco.org
2. EPICS (Engineering Projects in Community Service) https://engineering.purdue.edu/EPICS
3. Ashoka: Innovators for the Public https://www.ashoka.org
4. Design for Change https://www.dfcworld.com
5. NPTEL course: Ecology and Society, https://onlinecourses.nptel.ac.in/noc20_hs77/preview

SYLLABUS
SEMESTER - IV

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: PCC-206- AIM
Course Name: Database Management System

Teaching Scheme	Credits	Examination Scheme
Theory : 03 H/W	03	CCE: 30 Marks ESE: 70 Marks

Prerequisite Courses, if any: Data Structures & Algorithms

Companion Course, if any: --

Course Objectives:

1. To establish a strong conceptual foundation in database systems, covering fundamental principles, technologies, and best practices.
2. To understand the fundamental concepts of Relational Database Management System.
3. To introduce systematic approaches for database design, including Entity-Relationship modeling and normalization techniques.
4. To equip students with hands-on experience in SQL and procedural extensions (PL/SQL) for effective database interaction.
5. To familiarize with the key aspects of transaction processing, concurrency control and recovery management.
6. To learn and understand various database architectures and applications.
7. To introduce the recent trends in database technology.

Course Outcomes:

CO1: Explain the fundamental concepts, architecture, and functionalities of database management systems.
CO2: Analyze and design relational database (RDBMS) model to represent real-world database applications and demonstrate RDBMS principles.
CO3: Improve the database design through normalization.
CO4: Formulate database queries using SQL and PL/SQL for efficient data retrieval and manipulation.
CO5: Demonstrate ACID properties for transaction management and describe concurrency control protocols.
CO6: Explore and discuss recent trends in database technologies.

Course Contents

Unit No: I	**Introduction to Database Management System**	**08 Hours**

Basic concepts, Advantages of DBMS over file processing systems, Data abstraction and Data independence, Database languages, Components of a DBMS and Overall structure of DBMS, Multi-user DBMS architecture, Data Modeling: Basic concepts, entity, attributes, relationships, relations, constraints, keys, Data models.
ER and EER diagrams: Components of ER model, Conventions, Converting ER diagrams into tables, EER Model components, converting EER diagram into tables.

Exemplars/ Case Studies	1. Library Management System: Exemplar · Students understand basic DBMS concepts · They apply E-R model concepts to represent book and user data. · Sample Activity: Create an ER diagram and relational schema for the system. 2. Online Retail Store (e.g., Amazon): Case Study · Students analyze how DBMS supports operations like search, filters, and checkout.

Unit No: II	**Relational Model and Database Design**	**08 Hours**

Relational Model:
Relational Model Concepts (Domains, Attributes, Tuples, and Relations), Relational Model Constraints, Relational Database Schemas, Codd's rules.
Database design: Features of good relational database design, Purpose of Normalization, Data Redundancy and Data Anomalies, Functional Dependencies, Normal Forms (1NF, 2NF, 3NF, BCNF).

Exemplars/ Case Studies	Student/Timetable/ Reservation any Data Management System

Unit No: III	**Structured Query Language (SQL) & Procedural SQL (PL/SQL)**	**08 Hours**

Introduction to SQL, Basic Data Types and SQL Syntax, Data Definition Language (DDL), Constraints, Data Manipulation Language (DML), Clauses with SELECT statement: WHERE, ORDER BY, Pattern Matching with LIKE, IN, BETWEEN, Aggregate functions with GROUP BY` and HAVING, Joins, Sub-queries, Set Operations, Views, Index.

Introduction to PL/SQL: Overview of PL/SQL architecture, control structures, Cursors, PL/SQL Advanced Features: Procedures and Functions,
Triggers.

Unit No: IV	**Transaction Management and Concurrency Control**	**08 Hours**

Transaction Management:
Introduction to Database Transaction, Transaction states, ACID Properties, Concept of Schedule: Serial and concurrent Schedule. Serializability: Conflict and View, Cascaded Schedules, Recoverable Schedules.

Concurrency Control and Recovery Management:
Need for Concurrency Control, Lock-based protocols, Time stamp based protocol, Validation-based protocol, Multiple Granularity, Deadlock. Recovery Techniques: Shadow-Paging, Log-based Recovery, Check Point.

Unit No: V	**Emerging Trends in Database Technologies**	**06 Hours**

Needs, Challenges with traditional databases, Need for scalability, flexibility, and speed.
NoSQL Databases:
Definition and types: Document, Key-Value, Column, Graph; Example using MongoDB.

Cloud Databases:
What is DBaaS (Database-as-a-Service), Examples: AWS/Google Firebase; Benefits: scalability, cost, easy setup.

Introduction to Modern Database:

Big Data and Hadoop:
Basics of Big Data, Introduction to Hadoop and HDFS, Real-world examples (e.g., social media, online shopping), Simple explanation of how they store relationships.

AI/ML with Databases:
Basic idea of machine learning inside databases, Real-world applications: recommendations, fraud detection.

Exemplars/ Case Studies	· Short quiz on types of NoSQL databases · Assignment: Compare SQL vs NoSQL · Viva on real-life applications of modern databases · Mini-project idea: Student Attendance using NoSQL DB

Learning Resources

Text Books:

1. Silberschatz A., Korth H., Sudarshan S, "Database System Concepts", McGraw Hill Publication, Sixth Edition.

Reference Books:

1. Elmasri R., Navathe S., "Fundamentals of Database Systems", Pearson Education, Fourth Edition.
2. G. K. Gupta "Database Management Systems", Tata McGraw Hill.
3. Date C., "An Introduction to Database Systems", 8th Edition, Pearson Education
4. Ramkrishna R., Gehrke J., "Database Management Systems", 3rd edition, McGraw Hill.
5. Oracle PL/SQL Programming by Steven Feuerstein.
6. Reese G., Yarger R., King T., Williums H, "Managing and Using MySQL", Shroff Publishers and Distributors Pvt. Ltd., 2nd Edition.
7. Sadalage, P. J., Fowler, M., "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley.
8. MongoDB. (a.n.d.). MongoDB Manual. Retrieved from MongoDB Official Documentation.
9. Mahmood, Z. (Ed.), "Cloud Computing: Concepts, Technology and Architecture", Springer.
10. 10. White, T., "Hadoop: The Definitive Guide", 4th ed., O'Reilly Media.

Links to online SWAYAM/NPTEL Courses:

1. https://nptel.ac.in/courses/106/105/106105175/

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: PCC-207-AIM
Course Name: Foundation of Machine Learning

Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 3 Hrs./Week	3	CCE – 30 Marks End-Sem – 70 Marks

Prerequisite Courses, if any: Foundation of Artificial Intelligence, Data Structures, Basic Probability and Statistics, Algorithms

Companion Course, if any: --

Course Objectives:

1. To understand the basic concepts of machine learning
2. To learn various machine learning types and use it for the various machine learning tasks.
3. To optimize the machine learning model and generalize it.
4. To develop mathematical concepts required for Machine learning algorithms.
5. To explore supervised and unsupervised learning paradigms of machine learning.
6. To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.

Course Outcomes:

On completion of the course, students will be able to–

CO1: Recall the basic concepts of machine learning with different types of data and
CO2: Comprehend different types of supervised learning models and their relevant application.
CO3: List various regression techniques and evaluate their performance.
CO4: Analyze the different clustering algorithms and synthesize the patterns.
CO5: Summarize the needs and challenges of machine learning for real time applications

Course Contents

Unit No: I	**Introduction to Machine Learning**	**06 Hours**

Overview of Human Learning and Machine Learning, Comparison of Machine learning with traditional programming, ML vs AI vs Data Science.

Types of Machine Learning: Supervised, Unsupervised, Reinforcement learning

Basic/Key concepts: Generalization, Overfitting, Underfitting

Statistics & Linear Algebra: Probability, Bayes' theorem, Distributions, Variance, CoVariance, Matrices, Vectors, Eigenvalues, Gradient Descent

Data and Dimensionality: Feature Sets, Feature Extraction and Subset Selection, Feature Transformation. Dimensionality reduction techniques- PCA and LDA

Exemplars/Case Studies	Analyze Product Reviews
Reference Books	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar " Foundations of Machine Learning", MIT Press,2012

Unit No: II	Supervised Learning: Classification	06 Hours

Types of Supervised learning: Regression and Classification, Difference between Classification and Regression
Model Evaluation and Validation: Confusion Matrix, Accuracy, Precision, Recall, ROC Curve, F1-score, Cross-validation techniques (k-fold, stratified k-fold), Sub Sampling
Classification Algorithms:
Bayesian Learning - Naive Bayes Classifier, Bayesian Network, Applications of Bayesian Network,
k-Nearest Neighbors (k-NN)
Decision Trees - Introduction, Learning Decision Tree Using ID3 and Gini Index, CART, Overfitting, Ensemble Methods- Bagging (Random Forest), Boosting (XG Boost)
Support Vector Machines (SVM) - Support Vectors, Kernels: Linear, Polynomial and Radial Basis Function Kernel
Multiclass Classification techniques -One vs One, One vs Rest.

Exemplars/Case Studies	House Price Prediction
Reference Books	MACHINE LEARNING: An Algorithmic Perspective, Second Edition, Stephen Marsland

Unit No: III	Supervised Learning: Regression	06 Hours

Foundational Concepts: Different types of regression models, distributions, hypothesis testing, and confidence intervals**.**
Univariate Regression – Model Representation, Least-Square Method for finding values of the regression coefficients. Cost Functions: MSE, MAE, R-Square, Performance Evaluation, Optimizing Simple Linear Regression with Gradient Descent Algorithm.
Multivariate Regression –Model Representation, Polynomial Regression. Performance enhancement with Regularization techniques. Generalization Issues- Overfitting Vs. Underfitting, Bias Vs. Variance, Maximum Likelihood Function
Logistic Regression – Model, Cost Function

Exemplars/Case Studies	Stock Price Prediction
Reference Books	1. Andreas C. Müller & Sarah Guido, Introduction to Machine Learning with Python: A Guide for Data Scientists, O'Reilly Media

Unit No: IV	Unsupervised Learning	06 Hours

Introduction of Unsupervised Learning, Application of unsupervised learning,
Types of Unsupervised learning: Clustering algorithms - Partitioning Methods - k-means and k-Medoids, Hierarchical Methods - Agglomerative, Divisive, Density-based methods – DBSCAN, Apriori algorithm for association rule learning

Exemplars/Case Studies	Anomaly Detection in Network Security
Reference Books	1. S Sridhar and M Vijayalakshmi, “Machine Learning”, Oxford University Press, 2021

Unit No: V	**Advance topics in Machine Learning**	06 Hours

Overview of Reinforcement Learning, Components of Reinforcement Learning
Introduction to ML Frameworks: Definition and Importance of ML Frameworks – Types of ML Frameworks – Tensorflow – PyTorch – Scikit-learn – Keras – Challenges in ML Frameworks
Case-study of ML applications: Image recognition, speech recognition, Email spam filtering, Online fraud detection, Market basket analysis, Healthcare applications

Exemplars/Case Studies	Install and explore ML frameworks (Scikit-learn, Tensorflow, PyTorch, Keras)
Reference Books	1. https://home-wordpress.deeplearning.ai/wp-content/uploads/2022/03/andrew-ng-machine-learning-yearning.pdf

Learning Resources

Test Books

1. Tom M. Mitchell, ―Machine Learning‖, McGraw Hill
2. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Prentice Hall of India, 3rd Edition2014.
3. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar " Foundations of Machine Learning", MIT Press,2012.

Reference Books

1. Kevin P. Murphy, ―Machine Learning ― A Probabilistic Perspective‖, MIT Press
2. Stephen Marsland, ―Machine Learning an Algorithmic Perspective‖, CRC Press
3. Shai Shalev-Shwartz, Shai Ben-David, ―Understanding Machine Learning‖, Cambridge University Press
4. Peter Harrington, ―Machine Learning in Action‖, DreamTech Press
5. S Sridhar and M Vijayalakshmi, "Machine Learning", Oxford University Press, 2021.
6. M N Murty and Ananthanarayana V S, "Machine Learning: Theory and Practice", Universities Press (India) Pvt. Limited, 2024.

e-Books

1. https://aitskadapa.ac.in/e-books/AI&ML/MACHINE%20LEARNING/Machine%20Learning%20(%20etc.)%20(z-lib.org).pdf
2. https://info.deeplearning.ai/machine-learning-yearning-book
3. https://home-wordpress.deeplearning.ai/wp-content/uploads/2022/03/andrew-ng-machine-learning-yearning.pdf

Links to online SWAYAM/NPTEL Courses

1. Machine Learning, Prof. P. B. Ravindran, Department of Computer Science and Engineering, IIT Madras https://nptel.ac.in/courses/106106139
2. https://onlinecourses.nptel.ac.in/noc25_cs50/preview
3. https://nptel.ac.in/courses/106105152

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: PCC-208-AIM
Course Name: Probability & Statistics

Teaching Scheme	Credits	Examination Scheme
Theory: 02 H/W	**02**	**CCE: 30M** **ESE: 70M**

Prerequisite Courses, if any: **Set Theory and Logic, Differential and Integral Calculus, Basic Linear Algebra**

Companion Course, if any: **Data Science or Machine Learning Foundations, Statistical Inference, Numerical Methods**

Course Objectives:

1. To introduce the foundational principles of probability theory.
2. To study random variables, distributions, and expectation.
3. To analyze statistical measures including mean, variance, and higher-order moments.
4. To impart knowledge of sampling theory and estimation techniques.
5. To develop skills in hypothesis testing for real-world applications.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Apply probability theory to model uncertain systems and events. **L3**
CO2: Analyze and interpret various probability distributions. **L4**
CO3: Use moment generating functions and inequalities (Markov and Chebyshev) to analyze random variables. **L4**
CO4: Apply population parameters using sampling and construct confidence intervals. **L3**
CO5: Conduct statistical hypothesis tests to support decision-making. **L3**

Course Contents

Unit No: I	Probability Fundamentals and Set Theory	06 Hours

Algebra of sets, Axiomatic, classical, and frequentist definitions of probability, Conditional probability, independence, Bayes' theorem.

Exemplars/Case Studies	• Medical Testing and False Positives Context: Use of conditional probability and Bayes' Theorem in understanding false positives in COVID-19 tests. • Learning Outcome: Apply conditional probability and Bayes' Theorem to real-world diagnostic scenarios.
Reference Books	1. **S.M. Ross**, Introduction to Probability and Statistics for Engineers and Scientists – Chapters 1–2 2. **V.K. Rohatgi & A.K. Md. E. Saleh**, An Introduction to Probability and Statistics – Chapter 2 3. **H.J. Larson**, Introduction to Probability Theory and Statistical Inference – Chapter 1

Unit No: II	Random Variables and Expectation	06 Hours
Types of random variables (discrete, continuous, mixed), PMF, PDF, CDF, Expectation, variance, higher-order moments, Moment generating functions, Markov and Chebyshev inequalities.		
Exemplars/ Case Studies	Warranty Analysis in Manufacturing **Context**: Modeling the life of a product (e.g., a LED bulb) using exponential and normal distributions. **Learning Outcome**: Calculate expected life, variance, and reliability.	
Reference Books	**E.J. Dudewicz & S.N. Mishra**, Modern Mathematical Statistics – Chapter 3 **V.K. Rohatgi**, An Introduction to Probability and Statistics – Chapters 3–4 **S.M. Ross**, Introduction to Probability and Statistics – Chapters 3–4 **Mood, Graybill & Boes**, Introduction to the Theory of Statistics – Chapters 2–3	

Unit No: III	Distributions and Functions of Random Variables	06 Hours
Binomial, Poisson, Geometric, Exponential, Normal, Gamma, Beta, Transformation techniques, Joint distributions, marginal and conditional distributions, Covariance, correlation, bivariate normal distribution		
Exemplars/ Case Studies	• Traffic Flow Modeling Using Poisson Distribution • **Context**: Modeling the number of vehicles passing a toll gate per minute using Poisson distribution. • **Learning Outcome**: Understand real-world applications of discrete distributions and parameter estimation.	
Reference Books	1. **S.M. Ross** – Chapters 5–6 2. **W.W. Hines & D.C. Montgomery**, Probability and Statistics in Engineering – Chapter 4 3. **V.K. Rohatgi** – Chapter 5 4. **Mood, Graybill & Boes** – Chapters 4–5	

Unit No: IV	Hypothesis Testing and Decision Theory	07 Hours
Introduction to Sampling and Estimation: Sampling distributions, Central Limit Theorem, Point estimation: unbiasedness, consistency, Maximum likelihood and method of moments, Confidence intervals Hypothesis formulation, critical regions, Type I & II errors, Neyman-Pearson lemma, Z, t, Chi-square, and F tests, Goodness-of-fit, tests for proportions and variance, Applications in engineering and sciences.		

Exemplars/ Case Studies	Market Survey for Launching a New Product • **Context**: A company samples 100 consumers to estimate the average monthly expenditure on a fitness product. • **Learning Outcome**: Construct confidence intervals and evaluate sample bias. A/B Testing in E-commerce • **Context**: Comparing two website versions to determine which leads to better conversion rates using hypothesis testing. **Learning Outcome**: Formulate null and alternative hypotheses, conduct z/t-tests, and interpret results.
Reference Books	1. **Dudewicz & Mishra** – Chapters 5–6 2. **J.S. Milton & J.C. Arnold**, Introduction to Probability and Statistics – Chapters 6–7 3. **Rohatgi & Saleh** – Chapters 6–7 4. **Mood, Graybill & Boes** – Chapter 6 5. **S.M. Ross** – Chapter 7 6. **Mood, Graybill & Boes** – Chapters 7–9 7. **Milton & Arnold** – Chapter 9 8. **W.W. Hines & D.C. Montgomery** – Chapter 8

Unit No: V	**Hypothesis Testing and Decision Theory**	**05 Hours**
Hypothesis formulation, critical regions, Type I & II errors, Neyman-Pearson lemma, Z, t, Chi-square, and F tests, Goodness-of-fit, tests for proportions and variance, Applications in engineering and sciences.		
Exemplars/ Case Studies	A/B Testing in E-commerce • Context: Comparing two website versions to determine which leads to better conversion rates using hypothesis testing. • Learning Outcome: Formulate null and alternative hypotheses, conduct z/t-tests, and interpret results.	
Reference Books	1. S.M. Ross – Chapter 7 2. Mood, Graybill & Boes – Chapters 7–9 3. Milton & Arnold – Chapter 9 4. W.W. Hines & D.C. Montgomery – Chapter 8	

Learning Resources

S. N	Book Title	Author(s)	ISBN	Publisher	Edition / Year
1	Introduction to Probability and Statistics for Engineers and Scientists	Sheldon M. Ross	978-0124157822	Academic Press (Elsevier)	5th Edition, 2014

2	An Introduction to Probability and Statistics	V.K. Rohatgi, A.K. Md. E. Saleh	978-1118294405	Wiley	3rd Edition, 2015
3	Modern Mathematical Statistics	E.J. Dudewicz, S.N. Mishra	978-0471030151	Wiley	1st Edition, 1988
4	Introduction to the Theory of Statistics	A.M. Mood, F.A. Graybill, D.C. Boes	978-0070428645	McGraw-Hill	3rd Edition, 1974
5	Introduction to Probability and Statistics	J.S. Milton, J.C. Arnold	978-0079130341	McGraw-Hill Education	4th Edition, 2003
6	Introduction to Probability Theory and Statistical Inference	H.J. Larson	978-0471866453	Wiley	3rd Edition, 1982
7	Probability and Statistics in Engineering	W.W. Hines, D.C. Montgomery, D.M. Goldsman, C.M. Borror	978-0470631472	Wiley	4th Edition, 2003

E-books:

1. Introduction to Probability and Statistics for Engineers and Scientists Author(s): Sheldon M. Ross Publisher: Academic Press (Elsevier) Edition/Year: 5th Edition, 2014 ISBN: 978-0123948113 https://minerva.it.manchester.ac.uk/~saralees/statbook3.pdf
2. An Introduction to Probability and Statistics Author(s): Vijay K. Rohatgi, A.K. Md. Ehsanes Saleh, Publisher: Wiley Edition/Year: 2nd Edition, 2000 ISBN: 978-0471326724 https://www.usb.ac.ir/FileStaff/5518_2023-2-8-8-33-53.pdf
3. Modern Mathematical Statistics Author(s): Edward J. Dudewicz, Satya N. Mishra Publisher: Wiley Edition/Year: 1st Edition, 1988 ISBN: 978-0471814726 https://archive.org/details/modernmathematic0000dude/page/n5/mode/2up

NPTEL / SWAYAM Video Lectures:

1. NPTEL - Probability and Statistics by Prof. H.K. Kesavan (IIT Madras)
2. NPTEL - Probability and Statistics by Prof. Somesh Kumar (IIT Kharagpur)
3. SWAYAM – Fundamentals of Probability and Statistics

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: PCC-209-AIM
Course Name: Database Management System Lab (Practical)

Teaching Scheme	Credits	Examination Scheme
Practical : 02 H/W	**01**	**TW: 25 M** **PR :25 M**

Course Objectives:

1. Understand the fundamental concepts of database management.
2. To provide a strong formal foundation in database concepts, recent technologies and best industry practices.
3. To understand significance of SQLite.
4. To provide systematic database design approaches covering conceptual design, logical design and an overview of physical design.
5. To learn database implementation using MySQL.
6. To programme PL/SQL including stored procedures, stored functions and triggers.

Course Outcomes:

After completion of this course student will be able to

CO1: To analyze database models and entity relationship models.
CO2: To understand the relational database systems.
CO3: To design and implement a database schema for a given problem-domain.
CO4: To populate and query a database using SQL DDL and DML commands.
CO5: To implement PL/SQL including stored procedures, stored functions and triggers.
CO6: To design a backend database of any one organization: CASE STUDY.

Guidelines for Instructor's Manual

The faculty member should prepare the laboratory manual for all the experiments and it should be made available to the laboratory instructor/Assistant.

Guidelines for Student's Lab Journal

1. Student should submit term work in the form of handwritten journal based on specified list of assignments.
2. Practical Examination will be based on all the assignments in the lab manual.
3. Candidate is expected to know the theory involved in the experiment.
4. The practical examination should be conducted if and only if the journal of the candidate is complete in all respects.

Guidelines for Practical Assessment

1. Examiners will assess the student based on performance of students considering the parameters such as timely completion of practical assignment, methodology adopted for implementation of practical assignment, timely submission of assignment in the form of handwritten write-up along with results of implemented assignment, attendance etc.
2. Examiners will judge the understanding of the practical performed in the examination by asking some questions related to theory and implementation of experiments he/she has carried out.

3. Appropriate knowledge of usage of software and hardware related to respective laboratory should be checked by the concerned faculty member.

Suggested List of Laboratory Assignments

Group A: Study of Databases

1. Study of MySQL Open source software. Discuss the characteristics like efficiency, scalability, performance and transactional properties
2. Study of SQLite: What is SQLite? Uses of Sqlite. Comparison with SQL.

Group B: MySQL

Design any database with at least two entities and relationships between them. Draw suitable ER/EER
diagram for the system.

Implement the database using DDL and DML statements.

Create tables with primary key and foreign key and other constraints.

Perform following operations:

a. Alter table
b. Drop table
c. Index operations
d. Relational operators
e. Pattern matching
f. Aggregate functions with group by and having clauses
g. Nested queries
h. Set operators
i. Views
j. Sorting

Group C: PL/SQL

1. Write and execute PL/SQL stored procedure and function to perform a suitable task on the database. Demonstrate its use.
2. Write and execute suitable database triggers.

Reference Books

1. Dr. P. S. Deshpande, “SQL and PL/SQL for Oracle 10g Black Book”, Dream Tech.
2. Ivan Bayross, “SQL, PL/SQL: The Programming Language of Oracle”, BPB Publication.
3. 3. Reese G., Yarger R., King T., Williums H, “Managing and Using MySQL”, Shroff Publishers and Distributors Pvt. Ltd., 2nd Edition.

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: PCC-210-AIM
Course Name: Foundation of Machine Learning Lab

Teaching Scheme	Credits	Examination Scheme
Practical : 02 H/W	**01**	**OR: 25 M**

Prerequisites: Basic Concepts of Machine Learning

Course Objectives:

1. To apply **the fundamental concepts** of supervised and unsupervised machine learning algorithms and Feature extraction techniques
2. To apply classification algorithm techniques and evaluate the performance
3. To apply regression algorithm techniques and evaluate the performance
4. To apply unsupervised learning techniques

Course Outcomes: On completion of this course student will be able to –

CO1: Apply **the fundamental concepts** of supervised and unsupervised machine learning algorithms and Feature extraction techniques
CO2: Apply classification algorithm techniques and evaluate the performance
CO3: Apply regression algorithm techniques and evaluate the performance
CO4: Apply unsupervised learning techniques

Guidelines for Instructor's Manual

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

Guidelines for Student's Lab Journal

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

Guidelines for Laboratory /Term Work Assessment

1. Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student.
2. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage.
3. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness.

Guidelines for Practical Examination

1. Internal and external examiners should jointly prepare oral questions based on the syllabus.
2. During the oral assessment, the examiner should focus on:
   a. The student's ability to explain the implemented code and underlying logic.
   b. Understanding of core concepts like classes, inheritance, polymorphism, and exception handling.
3. Answering supplementary questions to assess advanced learning and application of concepts.
4. The student should demonstrate clear communication and effective problem-solving skills.

List of Assignments

Sr. No.	Assignment statement	CO Mapped	Hours
1	Implement assignment based on implementation of Supervised and Unsupervised Machine Learning Techniques using Python (scikit-learn) **Case Study:** *Customer Segmentation for a Retail Store*:A retail company wants to segment its customers based on purchasing behavior to tailor marketing strategies.	CO1	2 Hrs
2	Implement assignment based on feature extraction techniques for effective machine learning model building **Case Study:** *Sentiment Analysis of Movie Reviews*: A film review website wants to predict whether a movie review is **positive** or **negative** using machine learning. Since the input is text, **feature extraction** is critical for converting unstructured text into numerical features.	CO1	2 Hrs
3	Implement assignment based on naive bayes classifier and evaluate the performance (confusion matrix, accuracy, precision, recall, F-1 Score), **Case Study:** *SMS Spam Detection*: A telecom company wants to filter out **spam SMS messages** before delivering them to users. The goal is to build a machine learning model that can classify SMS messages as **spam** or **ham (not spam)** using a dataset of labeled messages.	CO2	2 Hrs
4	Implement assignment based on decision tree classifier and evaluate the performance (confusion matrix, accuracy, precision, recall, F-1 Score), **Case Study:** *Loan Approval Prediction System:* A bank wants to automate the **loan approval process** using a machine learning model. The model should predict whether a loan will be **approved** or **rejected** based on the applicant's profile.	CO2	2 Hrs
5	Implement assignment based on simple linear regression and evaluate the performance (Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), R-squared (R^2 Score)),	CO3	2 Hrs

	Case Study: *Predicting Student Scores Based on Study Hours:* An educational analyst wants to predict a student's score based on the number of hours they studied. A dataset is available with students' study hours and their corresponding scores.		
6	Implement assignment based on logistic regression for binary classifier and evaluate the performance, **Case Study:** *Predicting Diabetes in Patients:* A hospital wants to predict whether a patient has diabetes or not based on medical measurements. You are tasked with building a logistic regression model to assist in early diagnosis using patient data.	CO3	2 Hrs
7	Implement assignment based on K-Means clustering algorithm and evaluate the performance, **Case Study:** *Anomaly Detection in Network Security:*To detect **unusual or malicious activities (anomalies)** in a computer network by applying **unsupervised learning (K-Means Clustering)**. The algorithm will help separate **normal traffic** from **potential attacks or intrusions** without relying on labeled data.	CO4	2 Hrs
8	Implement assignment based on K-Medoid clustering algorithm and evaluate the performance, **Case Study:** *Telecommunication Customer Plan Grouping:* To segment telecom customers into meaningful clusters based on their **usage behavior**, such as call duration, data consumption, and text message usage. This segmentation helps telecom companies design personalized plans and offers.	CO4	2 Hrs

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: MDM-231-AIM
Course Name: Internet of Things

Teaching Scheme	Credits	Examination Scheme
Theory : 02 H/W	**02**	**CCE:30** **ESE:70**

Prerequisite Courses, if any: Logic Design & Computer Organization

Companion Course, if any: NA

Course Objectives:

1. To understand fundamentals of Internet of Things (IoT).
2. To apply comprehensive approach towards building Middleware for IoT and Security Challenges.
3. To apply the Fundamental IoT Mechanism and Key Technologies.
4. To apply applications using fundamentals of data analytic in IoT.
5. To apply Cloud based IoT implementations scenarios along with its societal and economic impact using case studies.

Course Outcomes:

1. Explain the given societal challenge using IoT.
2. Develop available platform for stated IoT security challenges.
3. Design Fundamental IoT Mechanisms and Key Technologies for IoT specified Environment.
4. Design and Implement Data and Analytic for IoT to solve real world problems.
5. Develop real world application scenarios of IoT along with its societal and economic impact using case studies.

Course Contents

Unit No: I	INTRODUCTION TO IOT	06 Hours

IoT Definition, General Observations, Overview and Motivation, Examples of Application, Exemplary Devices: Raspberry Pi and Arduino, Types of Sensor, IPv6 Role, Areas Development and Standardization, Scope of the Present Investigation.

Exemplars/ Case Studies	Install Arduino IDE 1.8.19 and use various IoT Sensors.
Reference Books	1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Willy Publication- 2013 978-1-118-47347-4, 466.

Unit No: II	MIDDLE WARE FOR IoT	06 Hours
Platform middleware, Embedded IoT Devices, Communication Middleware – M2M, RFID, WSN, SCADA, Software Middleware, Frameworks, Data standards, 5G for IoT, IoT information Security, Privacy and Governance.		
Exemplars/Case Studies	Design IoT Solution using RFID, WSN and SCADA middleware	
Reference Books	Honbo Zhou, "The Internet of Things in the Cloud A Middleware Perspective", CRC Press, 2013.	

Unit No: III	FUNDAMENTAL IoT MECHANISMS AND KEY TECHNOLOGIES	06 Hours
Identification of IoT Objects and Services, Structural Aspects of the IoT, Environment Characteristics, Traffic Characteristics, Scalability, Interoperability, Security and Privacy, Open Architecture, Key IoT Technologies, Device Intelligence, Communication Capabilities, Mobility Support, Device Power, Sensor Technology, RFID Technology, Satellite Technology.		
Exemplars/Case Studies	Design IoT based solution considering various Structural Aspects	
Reference Books	Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Willy Publication- 2013 978-1-118-47347-4, 466.	

Unit No: IV	DATA AND ANALYTICS FOR IOT	06 Hours
An Introduction to Data Analytic for IoT, IoT Data Analytic Overview, IoT using Machine Learning, Big Data Analytic Tools and Technology, Characteristics of big data, NoSQL Databases, Hadoop, Cloud Service, Edge Analytic Core Functions, Distributed Analytic Systems**.**		
Exemplars/Case Studies	Develop IoT Solution and use Data Analytic tools.	
Reference Books	Pethuru Raj, T. Poongodi, Balamurugan Balusamy, and Manju Khari , "The Internet of Things and Big Data Analytics", First edition published 2020.	

Unit No: V	CASE STUDIES	06 Hours

Case Studies: Smart Metering/Advanced Metering Infrastructure, e-Health/Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards Tracking (Following and Monitoring Mobile Objects).

Exemplars/Case Studies	Develop IoT based Smart Solution for various societal problems.
Reference Books	Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Willy Publication- 2013 978-1-118-47347-4, 466.

Learning Resources

Text Books:

1. Honbo Zhou, "The Internet of Things in the Cloud A Middleware Perspective", CRC Press, 2013.
2. AdrainMcEwen, Hakim Cassimally, "Designing the Internet of Things", Wiley, 2014.3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, "IoT Fundamentals: Networking Technologies, Protocols, Use cases for the Internet of things", Cisco Press – Paperback- 16 August 2017 978-1-58714-456- 1 599.
3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, "IoT Fundamentals: Networking Technologies, Protocols, Use cases for the Internet of things", Cisco Press – Paperback- 16 August 2017 978-1-58714-456- 1 599.

Reference Books:

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Willy Publication- 2013 978-1-118-47347-4, 466.
2. Arshdeep Bahga, Vijay K. Madisetti, "Internet of Things A Hands-on Approach", VPT, 1st Edition, 2014.
3. Rolf H. Weber, Romana Weber, "Internet of Things Legal Perspectives", Springer 2010, ISBN 978-3-642-11709-1.

Links to online SWAYAM/NPTEL Courses -

1. https://www.coursera.org/specializations/iot

2. https://onlinecourses.nptel.ac.in /noc22_cs53/preview

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: VSE- 270 - AIM
Course Name: Digital Marketing and social media

Teaching Scheme	Credits	Examination Scheme
Practical :04	2	Term Work :25 Practical: 25

Prerequisite Courses, if any: Understanding of design thinking and planning is essential.

Companion Course, if any:

Course Objectives: This course aims at enabling students,

1. To understand the basic concept of Digital Marketing.
2. To understand the basics of Mobile Marketing.
3. To familiarize with the knowledge of E-mail Marketing.
4. To introduce a comprehensive set of digital marketing tools commonly used in the industry.
5. To provide practical skills and knowledge necessary to utilize tools effectively for marketing purposes.
6. 6. To develop strategic approaches in selecting and implementing appropriate digital marketing tools based on specific marketing objectives and target audiences

Course Outcomes: After learning the course, the students should be able to:

1. Understand the core concepts of Digital Marketing.
2. Understand the basics of Emil & Mobile Marketing.
3. Use Search Engine Optimization tools for digital marketing campaigns.
4. Use social media marketing tools for digital marketing campaigns.
5. Apply digital marketing strategies using Mailchimp and WordPress.
6. 6. Apply strategic digital advertising techniques through Google Ads, create visually compelling graphics with Canva, and produce engaging video content on YouTube

Course Deliverables for Practical Sessions

Introduction to Digital marketing

The Concept , Need & Evolution of Digital Marketing, Reason for growing Importance of Digital Marketing in India, Digital Marketing: Types & Examples. The concept of Digital Marketing Mix, 7 P's of Online Marketing: Product, Price, Promotion, Place People, Process, Physical evidence, Methods of Online Marketing promotion. Case Study on Digital Marketing.

Social Media Analytics

Types of Analytics in Social Media: Analytics, Listening, Advertising Analytics, Analytics from CMS and CRM, The Analytics Process, Metrics, Dashboards, and Reports. Google Analytics Features, Benefits, and Limitations, Google Analytics Reports, Creating custom reports, Dashboard and Segments.

Key Performance Indicators

Selecting and Preparing KPIs, Pages and Landing Pages, Event Tracking and AdSense, Site Search, Optimizing Your Search Engine Marketing Consumer Generated Contents (CGC), Impact of social media, Advantages and Disadvantages of social media, Types of social media, social media for Business use, Community Building Principles.

Search Engine Optimization (SEO)
Search Engine Optimization Basics, Keyword Research, SEO Tool- SEMrush: Overview and Features, Top Search Engine Ranking Factors. Case Study: Dominos India: Building Traffic through content propagation

DM tools
Overview of Hootsuite: Dashboard and Features, Social Media Listening and Monitoring, Social Media Publishing and Scheduling. Campaign using Mailchimp: Overview of Mailchimp Features and Interface, Building Email Lists and Segmentation, Creating Email Campaigns: Templates and Content Design. Advertising tools: Google Ads,Canva Interface.

Guidelines:

1. The laboratory assignments are to be submitted by students in the form of a journal.
2. Journal consists of a prologue, certificate, table of contents and handwritten write-up of each assignment.

Guidelines for Laboratory/Term Work Assessment:

1. Continuous assessment of laboratory work is done based on overall performance and Laboratory performance of students.
2. Every evaluation for a laboratory assignment should offer a grade or marks based on parameters with appropriate weightage.
3. Suggested parameters for overall assessment as well as each Laboratory assignment include- timely completion, performance, innovation, efficiency, punctuality and neatness.

Guidelines for Laboratory Conduction:

1. Assignments on all concepts are mandatory.
2. Assignments on all concepts should be implemented using digital marketing tools.
3. Use of open-source tools is to be encouraged.

1	**Keyword Research and SEO Optimization** Using SEO tools such as SEMrush, conduct keyword research for a specific industry or topic: Create a list of high-volume and relevant keywords, and propose on-page and off-page SEO optimizations for a hypothetical website based on the keyword research findings.
2	**Social Media Content Calendar** Select a social media management tool like Hootsuite. Plan and create a social media content calendar for a one-week period, including content types, posting schedule, and target audience segments. Use the scheduling feature of the chosen tool to schedule posts across different Social media platforms.
3	**Email Marketing Campaign** Choose an email marketing platform such as Mailchimp or Constant Contact. Design and execute an email marketing campaign for a fictional product or service. Create

	email templates, segment the email list, and schedule the campaign. Analyze the campaign performance metrics such as open rates, click-through rates, and conversions.
4	**Social Media Advertising Campaign** Create a Facebook Business Manager account. Develop a social media advertising campaign on Facebook or Instagram for a chosen target audience. Define campaign objectives, audience targeting criteria, ad formats, and budget allocation. Monitor campaign performance metrics Such as reach, engagement, and conversion rates.
5	**Leveraging Instagram Influencers for Brand Promotion** Create an Instagram influencer outreach plan to promote a new line of eco-friendly skincare products, aiming to increase brand visibility and drive online sales among environmentally- conscious consumer
6	**Creating Canva Designs for YouTube Channel Branding** Design graphics for branding a YouTube channel focused on cooking tutorials. The channel name is "Tasty Bites Kitchen." The graphics to be created include a channel banner, a profile Picture (channel logo), and a thumbnail template for video thumbnails.
7	**Understand web analytics using tools like Google Analytics** Analyze website performance using Google Analytics and identify areas for optimization and improvement
8	**Create website using Word Press** Using Word press Plug-ins- Different Plug-ins, social media Plug-ins, page builder plug-ins: the elementor, how to insert a section, Google Micro sites cerate a website.

Learning Resources

Text Books:

1. The digital marketing Handbook, A step by step guide, Mohit Pawar, 2015 Edition.
2. Advanced Web Metrics with Google Analytics, SYBEX, Brian Clifton, Second Edition.
3. Social Media Analytics Strategy,Alex Goncalves, Apress

Reference Books:

1. Ian Dodson, The art of Digital Marketing, 2016, Wiley, 978-1-119-26570-2.
2. Vandana Ahuja. Digital Marketing,Oxford University Press,2015,ISBN-10. ISBN:0199455449.

e-sources:

1. https://skillshop.exceedlms.com/student/collection/648385-digital_marketing
2. https://www.coursera.org/courses?query=digital%20marketing

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: AEC-281-AIM
Course Name: Modern Indian Language (Marathi)

Teaching Scheme	Credits	Examination Scheme
Practical : 2 hrs / week	1	Term Work –50 marks
Tutorial : 1 hr / week	1	

Course Objectives: The course aims to:

अभ्यासक्रमाची उद्दिष्टे :

१. प्रगत भाषिक कौशल्यांची क्षमता विकसित करणे.
२. प्रसारमाध्यमांतील संज्ञापनातील स्वरूप आणि स्थान स्पष्ट करणे.
३. व्यक्तिमत्त्व विकास आणि भाषा यांच्यातील सहसंबंध स्पष्ट करणे.
४. लोकशाहीतील जीवनव्यवहार आणि प्रसारमाध्यमे यांचे परस्पर संबंध स्पष्ट करणे.
५. प्रसारमाध्यमांसाठी लेखनक्षमता विकसित करणे.

COURSE CONTENTS

Unit I & II (07 Hours & 08 Hours)

घटक	तपशील
१	१. भाषा आणि व्यक्तिमत्त्व विकास : सहसंबंध २. लोकशाहीतील जीवनव्यवहार आणि प्रसारमाध्यमे
२	प्रसारमाध्यमांसाठी लेखन १ वृत्तपत्रासाठी बातमीलेखन आणि मुद्रितशोधन २ नभोवाणीसाठी भाषणाची संहितालेखन ३ दूरचित्रवाणीसाठी माहितीपटासाठी संहितालेखन

Unit III & IV (07 Hours & 08 Hours)

१	१. भाषा, जीवन व्यवहार आणि नवमाध्यमे, समाजमाध्यमे २. नवमाध्यमे आणि समाजमाध्यमांचे प्रकार : ब्लॉग, फेसबुक, ट्विटर. ३. नवमाध्यमे आणि समाजमाध्यमांविषयक साक्षरता, दक्षता, वापर आणि परिणाम
२	१. वेबसाईट आणि ब्लॉग, ट्विटरसाठी लेखन २. व्यावसायिक पत्रव्यवहार

Learning Resources

Textbooks

संदर्भ ग्रंथ :

१ सायबर संस्कृती, डॉ. रमेश वरखेडे

२ उपयोजित मराठी, संपादक डॉ. केतकी मोडक, संतोष शेणई, सुजाता शेणई

३ ओळख माहिती तंत्रज्ञानाची, टिमोथी जे. ओ लिअरी

४ संगणक, अच्युत गोडबोले, मौज प्रकाशन, मुंबई.

५ इंटरनेट, डॉ. प्रबोध चोबे, मनोरमा प्रकाशन, मुंबई.

६ व्यावहारिक मराठी, डॉ. ल. रा. नसिराबादकर, फडके प्रकाशन, कोल्हापूर.

७ आधुनिक माहिती तंत्रज्ञानाच्या विश्वात, शिक्रापूरकर दीपक, मराठे उज्ज्वल, उत्कर्ष प्रकाशन, पुणे.

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: AEC-281-AIM
Course Name: Modern Indian Language (Hindi)

Teaching Scheme	Credits	Examination Scheme
Practical : 2 hrs / week	1	Term Work –50 marks
Tutorial : 1 hr / week	1	

Course Objectives: The course aims to:

उद्देश्य :

१. छात्रों में हिंदी भाषा श्रवण कौशल विकसित करना।
२. छात्रों में हिंदी भाषा संवाद कौशल विकसित करना।
३. छात्रों में हिंदी भाषा वाचन कौशल विकसित करना।
४. छात्रों में हिंदी भाषा लेखन कौशल विकसित करना।
५. हिंदी भाषा–विधि तथा भाषा–व्यवहार से अवगत करना।

COURSE CONTENTS

Unit I & II (07 Hours & 08 Hours)

इकाई	पाठ्यविषय
इकाई– I	**वर्ण विचार :** १) हिंदी वर्णमाला – परिचय २) लिपि – परिचय ३) वर्णों का उच्चारण और वर्गीकरण ४) स्वराघात ५) संधि : स्वर संधि, व्यंजन संधि, विसर्ग संधि।

Unit III & IV (07 Hours & 08 Hours)

इकाई– II	**भाषा कौशल शिक्षण : लघुकथाओं द्वारा भाषा कौशल शिक्षण (श्रवण, संवाद, वाचन, लेखन)** १) शिक्षा – ज्योति जैन २) पानी के पेड़ – ज्योति जैन ३) पशुभाषा – ज्योति जैन ४) अपशगुन – ज्योति जैन

Learning Resources

Textbooks

संदर्भ ग्रंथ :

१. हिंदी भाषा शिक्षण – संपा. हिंदी अध्ययन मंडल, सावित्रीबाई फुले पुणे विश्वविद्यालय, पुणे, राजकमल प्रकाशन, नई दिल्ली।

२. हिंदी व्याकरण – पं. कामताप्रसाद गुरु, प्रकाशन संस्थान, नई दिल्ली।

३. प्रयोजनमूलक हिंदी – डॉ. माधव सोनटक्के, लोकभारती प्रकाशन, नई दिल्ली।

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: EEM-241-AIM
Course Name: E-Commerce

Teaching Scheme	Credits	Examination Scheme
Tutorial : 1	1	TW – 25 Marks
Practical : 2	1	

Prerequisite Courses, if any: **Basic Knowledge of Computer Systems, Web Technologies, Internet, Networking Fundamentals**

Companion Course, if any: **Web Technologies**, **Digital Marketing**, **Entrepreneurship Development**

Course Objectives:

1. **Understand** the fundamental concepts of E-Commerce, including its definition, scope, features, business models, and comparison with traditional commerce.
2. **Understand** the components of E-Commerce infrastructure, including hardware, software, payment technologies, cloud services, and security tools.
3. **Analyse** various E-Commerce payment systems, highlighting their types, technologies, gateways, and associated legal and security frameworks.
4. **Apply** digital marketing and sales strategies to online platforms, focusing on branding, pricing, communication, and current trends.
5. **Evaluate** different E-Business models and **construct** suitable internet-based solutions based on structure, evolution, and business needs.
6. **Identify** potential E-Commerce security threats and **recommend** appropriate tools and practices for secure transactions and data protection.

Course Outcomes (COs)

By the end of this course, students will be able to:

CO1: Understand core concepts, scope, features, types, and models of E-Commerce, and compare them with traditional commerce.

CO2: Understand the technological infrastructure required for E-Commerce, including hardware, software, payment systems, cloud services, and monitoring tools.

CO3: Analyze the structure and functionality of various E-Commerce payment systems, and evaluate security protocols and legal aspects involved in online transactions.

CO4: Apply digital marketing techniques, web selling models, and pricing strategies to create an effective online presence and customer engagement.

CO5: Develop E-Business models by understanding their elements, evolution, and the implementation of internet-based solutions.

CO6: Identify key security threats in E-Commerce and recommend appropriate cryptographic, authentication, and data protection mechanisms.

Recommended Deliverables during Tutorial Sessions

Introduction to E-Commerce - 02 Hrs

Definition and Scope of E-Commerce, Features and Benefits of E-Commerce, Types of E-Commerce ,E-Commerce Business Models and Examples, Digital Markets and Digital Goods Traditional Commerce vs. E-Commerce, E-Commerce Trade Cycle, Advantages and Disadvantages of E-Commerce

Exemplars/Case Studies	1) E-Commerce Models in India (Amazon India, Flipkart, IndiaMART, OLX, Freelancer.com) 2) Online Marketplaces & M-Commerce (Amazon Marketplace, Paytm, BigBasket, Google Play Store) 3) Subscription & Digital Content Platforms (Netflix, Coursera/Udemy, Google Play Store) 4) Online Service Platforms (IRCTC, Zomato) 5) Hybrid and Specialized Models (Freelancer.com, BigBasket, Zomato – revisited for their multi-model strategies)
Reference Books	**1.** E-Commerce 2023: Business, Technology, Society • Author: Kenneth C. Laudon, Carol Guercio Traver • Publisher: Pearson **2.** Introduction to E-Commerce • Author: Jeffrey F. Rayport, Bernard J. Jaworski • Publisher: McGraw-Hill

Technology Backbone of E-Commerce - 03 Hrs	
Introduction to E-Commerce Infrastructure, Hardware Technologies for E-Commerce Software Technologies for E-Commerce, Payment and Transaction Technologies Cloud Services and DevOps for E-Commerce, Security and Monitoring Tool	
Exemplars/Case Studies	1) Scalable Cloud Infrastructure in E-Commerce (AWS, Alibaba Cloud, Netflix on AWS, Amazon using AWS) 2) Enterprise Hardware & Hosting Solutions (Dell EMC for eBay, Flipkart infrastructure, Magento, Shopify) 3) Backend Development & DevOps Practices (Java & Spring – Amazon, Jenkins & Kubernetes – Flipkart, Netflix DevOps) 4) Security Infrastructure in E-Commerce (SSL Certificates, Firewalls – Myntra/Amazon, Cloudflare) 5) Monitoring & Analytics Systems (Splunk, Cloudflare – Analytics & CDN)
Reference Books	**1.** E-Commerce Basics: Technology Foundations and E-Business Applications • Author: Gary P. Schneider • Publisher: Pearson **2.** E-Business Fundamentals • Author: Peter Eckersley, Paul Jackson, Lisa Harris • Publisher: Routledge

E-Commerce Payment Solutions: An Overview - 03 Hours	
Introduction to Payment Systems, Traditional Payment Model, Characteristics of Payment Systems, Online Payment Basics, Types of E-Commerce Payment Systems Payment Instruments and Technologies, SET Protocol for Credit Card Payment Payment Gateways and Service Providers, Security in Online Payments Internet Technologies and the Banking Industry, Regulatory and Legal Framework Trends and Innovations in Payment Systems	
Exemplars/Case Studies	1) Foundation and Evolution of Electronic Payments: Visa, MasterCard, RBI, Government Payments, NEFT, GDPR 2) Digital Wallets, Postpaid Models & Contactless Payments: Paytm Wallet, Amazon Pay Later, ZestMoney, Smart Cards, PhonePe, Google Pay 3) Real-Time Payment Systems & Mobile Apps: Google Pay, BHIM App, UPI 123PAY, SBI YONO, HDFC NetBanking

	4) Payment Gateways and Integration Platforms: Razorpay, BillDesk, PayU, Stripe, IRCTC, PayPal 5) Security & Authentication in Digital Payments: Two-Factor Authentication, PCI DSS Compliance, RBI Security Guidelines, GDPR
Reference Books	**1.** Electronic Payment Systems for E-Commerce • Author: Donal O'Mahony, Michael A. Hines • Publisher: Springer **2.** Payment Technologies for E-Commerce • Author: Stefan Schmid, Dieter Uckelmann • Publisher: Springer

E-Commerce Marketing & Sales Revolution - 02 Hours	
Introduction to Online Selling and Marketing, Selling on the Web: Revenue Models and Building a Web Presence, Online Marketplaces and Platforms, Website as a Selling Platform Marketing on the Web: Strategies and Communication, Creating and Maintaining Brands on the Web, Emerging Web Selling and Marketing Models, Digital Marketing Fundamentals Paid Advertising and Campaigns, Pricing Strategies and Discounts, Customer Support and Service, Legal and Ethical Considerations in Online Marketing, Emerging Trends in Web Selling and Marketing	
Exemplars/Case Studies	**1)** Online Seller Empowerment & Direct Sales: Meesho, Nykaa, Lenskart **2)** Multi-Seller Marketplaces & Seller Tools: Amazon, Flipkart, Snapdeal **3)** Social & Influencer Marketing Strategies: Zomato, boAt Lifestyle, CRED, Trell, Moj **4)** Digital Marketing Platforms & Paid Advertising: HubSpot, Google Digital Garage, Facebook Ads (Mamaearth), Google Ads (Cleartrip) **5)** Customer Engagement & Compliance: Flipkart Big Billion Days, Amazon Chatbot Support, ASCI Guidelines, EU Cookie Consent Law, Live Commerce (Myntra, Flipkart), WhatsApp Business
Reference Books	**1.** E-Commerce Marketing: Strategies for Engaging in E-Business • Author: Henry Chan, Raymond Lee • Publisher: Wiley **2.** Sizzle: Advanced E-Commerce SEO • Author: Lou Storiale • Publisher: Self-published / Online

E-Business Fundamentals and Model Development -03 Hrs	
Definition and Characteristics of E-Business, Elements and Structure of E-Business Evolution and Stages of E-Business, E-Business Models, Impact of E-Business Challenges in E-Business, Characteristics of Internet-Based Software and E-Business Solutions Developing an E-Business Model	
Exemplars/Case Studies	1) Early E-Business and Direct Models: IBM, Dell, Walmart 2) Platform and Marketplace Models: Amazon, Zomato, Etsy, Snapdeal 3) Subscription and Disruptive Models: Netflix, Uber 4) Cloud Solutions and SaaS Platforms: Salesforce CRM, Shopify 5) Security, Privacy, and Financial Ecosystems: Yahoo Data Breaches, Paytm Expansion
Reference Books	**1.** e-Business Fundamentals • Author: Peter Eckersley, Paul Jackson, Lisa Harris • Publisher: Routledge **2.** E-Business Essentials • Author: Efraim Turban, Jae Kyu Lee, David King • Publisher: Springer

E-Commerce Security: Tools and Best Practices	02 Hours
Introduction to E-Commerce Security, Security Threats and Vulnerabilities in E-Commerce, Cryptographic Tools for E-Commerce Security, Authentication and Authorization Mechanisms, Secure Payment Systems, Network and Application Security Tools, Data Privacy and Protection, Integration of E-Commerce Security with Business Systems, Emerging Trends in E-Commerce Security	
Exemplars/Case Studies	1) Transaction Security & Authentication: PayPal Security Measures, Two-Factor Authentication (Google), OAuth (Facebook Login), PCI DSS (Stripe), UPI Security (NPCI) 2) Data Breaches & Privacy Regulations: Equifax Data Breach, GDPR Compliance (EU), Apple App Tracking Transparency (ATT) 3) Encryption & Secure Communication: SSL/TLS Certificates (Amazon), PGP Encryption (ProtonMail) 4) Firewall & DDoS Protection: Cloudflare Firewall (Shopify), Web Application Firewall (Netflix), Salesforce Security Integration, ERP Security (Walmart) 5) Advanced Security Technologies: AI-Based Fraud Detection (PayPal), Blockchain for Secure Transactions (IBM Food Trust)
Reference Books	**1.** E-Commerce Security: A Global Status Report • Author: ISACA (Institute of Information Systems Audit and Control Association) • Publisher: ISACA **2.** E-commerce Security Methods, Protocols & Solutions • Author: Prashant Pittalia • Publisher: LAP Lambert Academic Publishing

Learning Resources

Unit 1: Introduction to E-Commerce

1) **E-Commerce Foundations - LinkedIn Learning**
   https://www.linkedin.com/learning/ecommerce-foundations
2) **Introduction to E-Commerce - Coursera (University of Illinois)**
   https://www.coursera.org/learn/ecommerce
3) **What is E-Commerce? - Investopedia**
   https://www.investopedia.com/terms/e/ecommerce.asp

Unit 2: Technology Backbone of E-Commerce

4) **E-Commerce Infrastructure - TutorialsPoint**
   https://www.tutorialspoint.com/e_commerce/e_commerce_infrastructure.htm
5) **Cloud Computing for E-Commerce - edX**
   https://www.edx.org/learn/cloud-computing

Unit 3: E-Commerce Payment Solutions: An Overview

6) **Introduction to Payment Systems - Coursera**
   https://www.coursera.org/learn/payment-systems
7) **Payment Gateway Explained - PayPal**
   https://www.paypal.com/uk/webapps/mpp/payment-gateway
8) **Payment Security Basics - PCI Security Standards Council**
   https://www.pcisecuritystandards.org/

Unit 4: E-Commerce Marketing & Sales Revolution

9) **Digital Marketing Specialization - Coursera (University of Illinois)**
   https://www.coursera.org/specializations/digital-marketing
10) **Inbound Marketing Course - HubSpot Academy**
    https://academy.hubspot.com/courses/inbound-marketing

Unit 5: E-Business Fundamentals and Model Development

11) **E-Business Concepts - OpenLearn**
https://www.open.edu/openlearn/money-business/leadership-management/e-business/content-section-0
12) **Business Model Generation - Coursera**
https://www.coursera.org/learn/business-model-generation

Unit 6: E-Commerce Security: Tools and Best Practices

13) **E-Commerce Security Fundamentals - Pluralsight**
https://www.pluralsight.com/courses/ecommerce-security-fundamentals
14) **Cybersecurity for E-Commerce - Coursera**
https://www.coursera.org/learn/cyber-security
15) **OWASP Top Ten Security Risks**
https://owasp.org/www-project-top-ten/

Text Books

1. E-Commerce 2023: Business, Technology, Society by Kenneth C. Laudon, Carol Guercio Traver, Pearson
2. E-Commerce Basics: Technology Foundations and E-Business Applications by Gary P. Schneider, Pearson
3. Electronic Payment Systems for E-Commerce by Donal O'Mahony, Michael A. Hines, Springer
4. e-Business Fundamentals by Peter Eckersley, Paul Jackson, Lisa Harris, Routledge
5. E-Commerce Security Methods, Protocols & Solutions by Prashant Pittalia, LAP Lambert Academic Publishing

Reference Books :-

1. E-Commerce Basics: Technology Foundations and E-Business Applications by Gary P. Schneider, Pearson
2. E-Commerce Marketing: Strategies for Engaging in E-Business by Henry Chan, Raymond Lee, Wiley
3. Fundamentals of E-Commerce by Ravi Kalakota, Andrew B. Whinston, Pearson Education India
4. E-Commerce Security: Risk Management and Control by Russell S. Dunkle, Wiley

e-Books

1. Electronic Commerce (12th Edition) by Gary P. Schneider, Cengage Learning
2. E-Commerce: Fundamentals and Applications by Henry Chan, Raymond Lee, Tharam Dillon, Elizabeth Chang, Wiley
3. e-Business Fundamentals by Peter Eckersley, Lisa Harris, Paul Jackson, Routledge
4. Frontiers of Electronic Commerce by Ravi Kalakota, Andrew B. Whinston, Addison-Wesley
5. Advances in Security and Payment Methods for Mobile Commerce by Donal O'Mahony, Michael A. Peirce, Hitesh Tewari, Springer

Links to online SWAYAM/NPTEL Courses

1. E-Business
https://onlinecourses.nptel.ac.in/noc19_mg54/preview
2. E-commerce Technologies
https://swayam.gov.in/nd2_cec19_cm01/preview
3. Digital Marketing
https://swayam.gov.in/nd2_ugc19_hs26/preview
4. Basics of Digital Marketing
https://swayam.gov.in/nd2_cec19_mg23/preview
5. BCOS-184 E-Commerce
https://swayam.gov.in/nd2_nou22_cm07/preview

Guidelines for Student's Lab Journal

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

Guidelines for Laboratory /Term Work Assessment

1. Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student.
2. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage.
3. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness.

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments without changing its complexity level and distribute among batches of students. Use of open-source software is encouraged. Set of suggested assignment list is provided, instructors may take different case studies with similar complexity level.

Operating System Recommended: Linux (Ubuntu, Fedora, Debian, etc.) – 64-bit open-source Linux or its derivative recommended.

List of Assignments [Any 6 Assignments] Tools are recommended , however staff members may take liberty to make use of suitable /available tools [proprietary/open source]

Lab Assignment 1: Creating a Simple Static E-Commerce Website
Topic: Introduction to E-Commerce
Objective: Design a basic online store homepage with HTML/CSS showcasing categories, products, and navigation.
Tools: HTML5, CSS3
Reference: Laudon & Traver – Chapter 1

Lab Assignment 2: Implementing Product Listing and Search Functionality
Topic: Technology Backbone of E-Commerce
Objective: Develop a dynamic product catalog with search/filter features using JavaScript or PHP.
Tools: JavaScript/PHP, MySQL
Reference: Schneider – Chapter 4

Lab Assignment 3: Simulating a Payment Workflow Using Sandbox APIs
Topic: E-Commerce Payment Solutions
Objective: Integrate PayPal/Stripe Sandbox API to simulate checkout and payment confirmation.
Tools: PayPal Sandbox / Stripe Test API
Reference: O'Mahony – Chapters 2 & 3

Lab Assignment 4: Creating a Digital Marketing Campaign (SEO + Email)

Topic: Marketing & Sales
Objective: Create an SEO-optimized product page and set up a basic email marketing workflow using Mailchimp or Sendinblue.
Tools: Google SEO tools, Mailchimp
Reference: Laudon & Traver – Chapter 6

Lab Assignment 5: Implementing a Simple Shopping Cart with Session Handling
Topic: Tech Backbone of E-Commerce
Objective: Create an add-to-cart functionality with session-based quantity tracking and checkout.
Tools: PHP/JavaScript, Sessions
Reference: Schneider – Chapter 5

Lab Assignment 6: Designing a Business Model Canvas for an E-Commerce Idea
Topic: E-Business Model Development
Objective: Use the Business Model Canvas (BMC) to outline a business model for a hypothetical E-Commerce startup.
Tools: Canva, BMC Templates
Reference: Eckersley – Chapter 3

Lab Assignment 7: Implementing Basic Security Features for Login Page
Topic: E-Commerce Security
Objective: Secure a login system using hashing (bcrypt/MD5), CAPTCHA, and validation.
Tools: PHP, bcrypt, reCAPTCHA
Reference: Pittalia – Chapter 4

Lab Assignment 8: Log Analysis & Threat Detection Simulation
Topic: E-Commerce Security – Best Practices
Objective: Parse and analyze sample server logs to identify suspicious activity like repeated failed logins or SQLi attempts.
Tools: Python, ELK Stack (optional), Regex
Reference: Pittalia – Chapter 6

Mini Project

These are suitable for group mini-projects (3–4 students) and incorporate real-world applications across the course topics. **Suggested Statements for reference –**

Mini Project 1: End-to-End E-Commerce Web App with Payment Gateway
Problem Statement: Develop a fully functional online store (e.g., bookstore or electronics) that allows product browsing, cart management, secure checkout, and dummy payment integration.
Topics Covered: Tech Backbone, Payment Solutions, Security
Tools: HTML/CSS, PHP/Node.js, MySQL, PayPal Sandbox

Mini Project 2: AI-Powered Product Recommendation Engine

Problem Statement: Build a recommendation engine that uses customer browsing and purchase data to suggest relevant products.
Topics Covered: Marketing & Sales Revolution
Tech Used: Python, Flask, Pandas, Scikit-learn (Basic ML)

Mini Project 3: E-Commerce Risk & Threat Monitoring Dashboard
Problem Statement: Create a dashboard that visually tracks failed login attempts, suspicious requests, and bot detection across an E-Commerce platform.
Topics Covered: Security Best Practices
Tech Used: Python, Log Parser, JavaScript Charts (Chart.js, D3.js)

Mini Project 4: Comparison Tool for E-Payment Options
Problem Statement: Build a web tool that allows comparison between payment modes like UPI, Net Banking, Credit Cards, in terms of fees, transaction speed, and availability.
Topics Covered: Payment Solutions
Tools: PHP/Node.js, APIs (if applicable), Charts

Mini Project 5: Startup Model Planner for E-Commerce Businesses
Problem Statement: Design a web-based platform that helps new startups choose the right E-Commerce business model (e.g., subscription vs. affiliate) based on their goals.
Topics Covered: E-Business Fundamentals
Tools: Web development stack + logic-based recommendation engine

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Machine Learning (2024 Course)
Course Code: VEC-251-AIM
Course Name: Environmental Studies

Teaching Scheme	Credits	Examination Scheme
Theory : 2 H/W	2	CCE: 15 ESE: 35

Prerequisite Courses, if any: Biology, Geography, Environmental science

Companion Course, if any: Basic Science, Indian Knowledge System

Course Objectives:

1. To introduce students with environmental studies, including its elements, sustainability, and interdisciplinary applicability.
2. To examine biotic and abiotic factors within an ecosystem, to identify food chains, webs, as well as energy flow and relationships.
3. To identify and analyze various conservation methods and their effectiveness in relation to renewable and nonrenewable natural resources.
4. To introduce students to biodiversity, its threats, and conservation, with a focus on India's heritage.
5. To be able to assess how humans affect the environment in terms of population, carbon footprint, and ethics.
6. To examine a range of environmental issues in the field, and relate these to scientific theory.

Course Outcomes: On completion of the course, learner will be able to–

CO1: Demonstrate an integrative approach to environmental issues with a focus on sustainability.
CO2: Explain and identify the role of the organism in energy transfers in different ecosystems.
CO3: Distinguish between and provide examples of renewable and nonrenewable resources & analyze personal consumption of resources
CO4: Identify key threats to biodiversity and develop appropriate policy options for conserving biodiversity in different settings.
CO5: Understand environmental pollution and related laws, assess human population impacts on Natural resources, and develop scientific skills to analyze and address environmental issues effectively.
CO6: Learn skills required to research and analyze environmental issues scientifically and learn how to use those skills in applied situations such as careers that may involve environmental problems and/or issues.

Course Contents

Unit No: I	Introduction to Environmental Studies & it's Ecosystems	07 Hours

Definition of environment and components (biotic & abiotic), importance and scope of environmental studies, concept of sustainability and sustainable development, multidisciplinary nature of environmental studies.
Definition, structure and function of ecosystems, food chains, food webs, and ecological pyramids, energy flow and ecological succession
Case studies: Forest, grassland, desert, and aquatic ecosystems

Exemplars/Case Studies	**-Plastic waste crisis in India,** Use of solar rooftops in Gujarat - Sundarbans Mangrove Forests, Water pollution impact on river Yamuna ecosystem

Unit No: II	**Natural Resources: Renewable and Non-renewable Resources**	**06 Hours**
Land Resources: Land use change, soil erosion, land degradation. **Deforestation**: Impacts of mining and dam projects on forests and biodiversity. **Water Resources**: Overuse of surface and groundwater; water conflicts. **Atmosphere:** Air circulation and precipitation basics. **Energy Resources**: Renewable and non-renewable energy; alternative sources.		
Exemplars/Case Studies	Rainwater Harvesting in Tamil Nadu, Narmada Bachao Andolan – Dam building and displacement	

Unit No: III	**Biodiversity and Conservation**	**06 Hours**
Definition of Biodiversity: Levels of biodiversity: genetic, species, ecosystem, India's biogeographic zones and hotspots **Value of biodiversity:** Ecological, economic, social, ethical, aesthetic, and informational values of biodiversity with examples. **Threats to biodiversity**: Habitat loss, poaching, invasions. **Conservation methods**: In-situ and Ex-situ		
Exemplars/Case Studies	Project Tiger – Conservation success, man-animal conflict in Sundarbans	

Unit No: IV	**Environmental Pollution and Human Role**	**05 Hours**
Types of pollution & their causes, effects and controls: Air, water, soil, noise, nuclear, Control measures and pollution case studies **Global concerns**: Climate change, ozone depletion, acid rain. **Environmental laws:** EPA, Forest Act, Water and Air Act **Human impact**: Population, carbon footprint, ethics. Environmental movements- Chipko, Silent valley, Bishnios of Rajasthan and public awareness **Environmental ethics:** Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi). **E-waste management and laws**		
Exemplars/Case Studies	Solid Waste Management by Indore Municipal Corporation, Air Pollution in Delhi NCR – Health and Policy Implications	

Learning Resources

Reference Books:

1. Carson, R. (2002). *Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. (1993). *This Fissured Land: An Ecological History of India*. University of California Press.
3. Gleeson, B., & Low, N. (Eds.) (1999). *Global Ethics and Environment*. Routledge.
4. Gleick, P.H. (1993). *Water in Crisis*. Oxford University Press.
5. Groom, M.J., Meffe, G.K., & Carroll, C.R. (2006). *Principles of Conservation Biology*. Sinauer Associates.
6. Grumbine, R.E., & Pandit, M.K. (2013). *Threats from India's Himalaya Dams*. *Science*, 339:36-37.
7. McCully, P. (1996). *Rivers No More: The Environmental Effects of Dams*. Zed Books.
8. McNeil, J.R. (2000). *Something New Under the Sun: An Environmental History of the Twentieth Century*. Norton.

e-Books:

1. Arunima Sarma , Krishna Gopal Bhattacharya;Comprehensive Environmental Studies
2. Renuka Gupta;Ecosystem structures & functions
3. Dr Sunil Mittal;Biodiversity and conservation

Links to online SWAYAM/NPTEL Courses:

1. https://onlinecourses.swayam2.ac.in/cec25_es01
2. https://onlinecourses.swayam2.ac.in/ugc25_ge17
3. https://onlinecourses.nptel.ac.in/noc25_ge76
4. https://archive.nptel.ac.in/courses/105/102/105102089

Savitribai Phule Pune University
SE - Artificial Intelligence and Machine Learning (2024 Course)
National Education Policy (NEP)-2020 Compliant Syllabus

Team Members Behind Curriculum Structure Design

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Course Coordinator - SE AIML

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