Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology

National Education Policy (NEP)-2020 Compliant Curriculum

SE - Second Year Engineering (2024 Pattern) in

Artificial Intelligence and Data Science

(With effect from Academic Year 2025-26)

www.unipune.ac.in

Contents

Nomenclature

AEC   Ability Enhancement Course

AICTE   All India Council for Technical Education

AIDS   Artificial Intelligence and Data Science

CEP   Community Engagement Project

EEM   Entrepreneurship/Economics/Management Courses

MDM   Multidisciplinary Minor

MOOC   Massive Open Online Course

NEP   National Education Policy

NPTEL   National Programme on Technology Enhanced Learning

OE   Open Elective

PCC   Program Core Course

PEO   Programme Educational Objectives

PSO   Program Specific Outcomes

SWAYAM   Study Webs of Active-Learning for Young Aspiring Minds

UGC   University Grants Commission

VEC   Value Education Course

VEC   Value Education Course

VSE   Vocational and Skill Enhancement

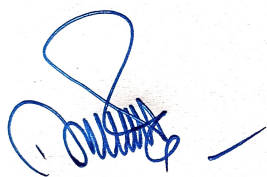WK   Knowledge and Attitude Profile

Dear Students and Teachers,

We, the members of Board of Studies Computer Engineering, are very happy to present Second Year AI & DS syllabus effective from the AY Year 2025-26. Subsequently this will be carried forward for TE and BE in the AY 2026-27, 2027-28, respectively.

Artificial Intelligence and Data Science have emerged as transformative forces reshaping industries, driving innovation, and impacting our daily lives. Recognizing the growing importance and pervasive nature of these fields, we have designed this comprehensive syllabus to equip students with the foundational knowledge and practical skills. This curriculum is meticulously crafted to provide a holistic learning experience, blending theoretical concepts with hands-on applications. The revised syllabus falls in line with the objectives of NEP-2020, Savitribai Phule Pune University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets. We believe that this well-structured and comprehensive syllabus will serve as a robust foundation for aspiring Computer Engineering and AI professionals, enabling them to contribute significantly to the technological progress and address the challenges of the 21st century.

We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Dr. Nilesh Uke
Chairman - Board of Studies (Computer Engineering)
Savitribai Phule Pune University

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Second Year Artificial Intelligence and Data Science- 2024 Pattern

Program Specific Outcomes (PSO)

- **PSO1:** Demonstrate proficiency in essential concepts of computer science and data science and programming solutions.

- **PSO2:** Formulate robust software design, execution, and testing strategies employing a software paradigms and Artificial Intelligence knowledge to solve real word problems.

- **PSO3:** Apply the techniques of AI and Data Science for forecasting future events in the domain of Healthcare, Education, and Agriculture, Automation , Transport etc

Programme Educational Objectives (PEO)

Program Educational Objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

PEO	PEO Focus	PEO Statements
PEO1	Core competence	To produce graduates equipped with cutting-edge skills in Artificial Intelligence (AI) and Data Science (DS), with expertise in domains such as Machine Learning (ML), Natural Language Processing (NLP), Generative AI, enabling them to collaborate effectively in interdisciplinary teams to solve real-world industrial and societal challenges.
PEO2	Problem solving skills and Ethics	To empower graduates to think critically, apply mathematical, computational, and ethical frameworks, and design scalable, secure, and fair AI-driven systems
PEO3	Professionalism and Lifelong Learning	To inculcate the ability to adapt to changing technology through continuous learning and contribute to research, innovation, and entrepreneurship in AI and Data Science.

Knowledge and Attitude Profile (WK)

A Knowledge and Attitude Profile (KAP), often represented as WK (Knowledge and Attitude Profile) in some contexts, is a framework or assessment tool used to evaluate an individual's knowledge and attitudes related to a specific area, topic, or domain.

WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9	Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Reference: Self-Assessment Report (SAR) Format Undergraduate Engineering Programs Graduate Attributes and Professional Competencies Version 4.0 (GAPC V4.0) - (August 2024) Page 55.

Programme Outcomes (PO)

Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. On successful completion of B.E. in Artificial Intelligence and Data Science, graduating students/graduates will be able to:

PO1	Engineering knowledge	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO2	Problem analysis	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3	Design / Development of Solutions	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO4	Conduct Investigations of Complex Problems	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO5	Engineering Tool Usage	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO6	The Engineer and The World	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8	Individual and Collaborative Team work:	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	Communication	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	Life-Long Learning	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Reference: Self-Assessment Report (SAR) Format Undergraduate Engineering Programs Graduate Attributes and Professional Competencies Version 4.0 (GAPC V4.0) - (August 2024) Page 56.

- **Course Outcomes (CO):** Course Outcomes are narrower statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.

- **Assessment:** Assessment is one or more processes, carried out by the institution, that identify, collect, and prepare data to evaluate the achievement of Program Educational Objectives and Program Outcomes.

- **Evaluation:** Evaluation is one or more processes, done by the Evaluation Team, for interpreting the data and evidence accumulated through assessment practices. Evaluation determines the extent to which Program Educational Objectives or Program Outcomes are being achieved, and results in decisions and actions to improve the program

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) :

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

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

3. 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.

4. 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

5. CCE of 15 marks based on all the Units of course syllabus to be scheduled and conducted at institute level. To design a 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.	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 and 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, Analyze, 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.

* Analyzing: Drawing connections among ideas.

* Evaluating: Justifying a decision or course of action.

* Creating: Producing new or original work (if applicable).

– **Detailed Scheme for 70 Marks :** 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.

– **Detailed Scheme for 35 Marks :** Unit-Wise Allocation (08 Marks for Unit 1 , 09 Marks for Unit 2, Unit 3 and Unit 4) : 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.

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Second Year Artificial Intelligence and Data Science- 2024 Pattern

Level 5.0

Course Code	Course Type	Course Name	Teaching Scheme			Examination Scheme						Credits			
			Theory	Tutorial	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Tutorial	Practical	Total
PCC-201-AID	Program Core Course	Data Structures	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-202- AID	Program Core Course	Artificial Intelligence	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-203- AID	Program Core Course	Operating System	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-204-AID	Program Core Course	Data Structures Laboratory	-	-	4	-	-	25	50		75	-	-	2	2
PCC-205- AID	Program Core Course	Artificial Intelligence Laboratory	-	-	2	-	-	25	-	25	50	-	-	1	1
	Open Elective	*Open Elective - I	2	-	-	15	35	-	-	-	50	2	-	-	2
MDM-221- AID	Multi disciplinary Minor	Digital Electronics and Logic Design	2	-	-	30	70	-	-	-	100	2	-	-	2
EEM-231- AID	Entrepreneurship/ Management	Entrepreneurship Development	-	1	2	-	-	25	-	-	25	-	1	1	2
VEC-232- AID	Value Education Course	Universal Human Values and Professional Ethics	2	-	-	15	35	-	-	-	50	-	-	-	2
CEF-241-AID	Community Engagement Project	Community Engagement Project	-	-	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.

- Elective II - Project Management, Business Analytics, Financial Management can be opted from Inter-Disciplinary studies, Commerce and Management faculty respectively.

Second Year Artificial Intelligence and Data Science- 2024 Pattern -Level 5.0

Course Code	Course Type	Course Name	Teaching Scheme			Examination Scheme						Credits			
			Theory	Tutorial	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Tutorial	Practical	Total
PCC-251-AID	Program Core Course	Database Management systems	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-252- AID	Program Core Course	Data Science	2	-	-	30	70	-	-	-	100	2	-	-	2
PCC-253- AID	Program Core Course	Probability & Statistics	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-254- AID	Program Core Course	Database Management Laboratory	-	-	2	-	-	25	25	-	50	-	-	1	1
PCC-255- AID	Program Core Course	Data Science Laboratory	-	-	2	-	-	-	-	25	25	-	-	1	1
	Open Elective	*Open Elective II	2	-	-	15	35	-	-	-	50	2	-	-	2
MDM-271- AID	Multi Disciplinary Minor	Embedded Systems	2	-	-	30	70	-	-	-	100	2	-	-	2
VSE-281- AID	Vocational and Skill Enhancement	Object Oriented Programming	-	-	4	-	-	25	25	-	50	-		2	2
AEC-282- AID	Ability Enhancement Course	Modern Indian Language (Marathi)	-	1	2	-	-	50	-	-	50	-	1	1	2
EEM-283- AID	Entrepreneurship /Economics	Technology Commercialization & Startup Development	-	1	2	-	-	25	-	-	25	-	1	1	2
VEC-284- AID	Value Education Course	Environmental Studies	2	-	-	15	35	-	-	-	50	2	-	-	2
Total			14	2	12	150	350	125	50	25	700	15	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 I - Financial Accounting, Digital Finance, Digital Marketing can be opted from Commerce and Management faculty.

Elective II - Project Management, Business Analytics, Financial Management can be opted from Inter-Disciplinary studies, Commerce and Management faculty respectively.

Savitribai Phule Pune University, Pune

Maharashtra, India

SE - Artificial Intelligence and Data Science

Semester - III

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science - 2024 Pattern		
PCC-201- AID: Data Structures		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	CCE : 30 Marks End-Semester: 70 Marks

Prerequisite Courses, if any :

1. Programming and Problem Solving

2. Fundamentals of Programming Languages

Companion Course if any: NA

Course Objectives: The course aims to:

1. To introduce fundamentals of data structures and its applications

2. To develop problem-solving skills using algorithms

3. To analyze the algorithmic complexity

4. To develop proficiency in implementing linear and non-linear data structures.

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

- CO1: **Analyze** the performance of searching and sorting techniques based on the Time and Space complexities of Algorithms

- CO2: **Apply** different hashing techniques, including various collision resolution methods

- CO3: **Demonstrate** the use of Linked lists to store and process structured data

- CO4: **Apply** principles of Stack and Queue Data Structures to **solve** real time problems

- CO5: **Demonstrate** the primitive operations of nonlinear data structure -Trees and graphs

Course Contents

Unit I - Data Structures & Algorithms: Searching and Sorting (09 Hours)

Introduction of Data Structures & types. Complexity of algorithm: Space complexity, Time complexity, Asymptotic notation- Big-O, Theta and Omega, finding complexity using step count method, Analysis of programming constructs-Linear, Quadratic, Cubic, Logarithmic.

Searching: Sequential Search, Binary Search.

Sorting: Insertion sort, Bubble Sort, Merge sort, Selection Sort, Quick sort, Radix sort.

Hash: Hash Table, Hash Function, Collision Resolution Techniques in Hashing-Chaining, Open Addressing-Linear, Quadratic Probing and Double Hashing. Hash table overflow open addressing and chaining.

Case Study: Employee Records Database Optimization, finding employees based on salary or sorting them by department using Array

Unit II Memory Allocation & Linked List Operations (09 Hours)

Introduction to Static and Dynamic Memory Allocation.

Linked List: Introduction of Linked Lists, Realization of linked list using dynamic memory management, operations on Linked Lists, Linked List as ADT, Types of Linked List: singly linked, linear and Circular Linked Lists, Doubly Linked List, Doubly Circular Linked List, Primitive Operations on Linked List-Create, Traverse, Search, Insert, Delete, Sort, Concatenate. Polynomial Manipulations-Polynomial addition. Generalized Linked List (GLL) concept.

Case Study : Growing employee database dynamically using LL.

Unit III Linear Data Structure :Stacks, Queues   (09 Hours)

Stack: Introduction of stack, stack Abstract Data Type, Representation of Stacks Using Sequential Organization, stack operations, Applications of Stack- Expression Evaluation and Conversion. Recursion- concept.

Queue: Introduction of Queue, Queue as Abstract Data Type, Representation of Queue using Sequential organization. Queue Operations. Circular Queue and its advantages, Deque-introduction, Priority Queue.

Case study: Backtracking algorithmic strategy, Use of stack in backtracking.
Case study: Job scheduling using priority queue.

Unit IV Non-linear Data Structure: Tree   (09 Hours)

Tree: Introduction of tree, Representations, Traversals, Binary tree, Binary search tree, Threaded Binary search tree- concepts, threading, insertion and deletion of nodes, Optimal Binary Search Tree (OBST), Height Balanced Tree-
AVL tree, Heap Tree

Case study : Compare the complexity of BST and Linear search

Unit V Non-linear Data Structure: Graph   (09 Hours)

Graph: Introduction of graph, storage representation, Adjacency matrix, adjacency list, DFS, BFS, Minimum spanning Tree - Prims and Kruskal Algorithms, Dijkstra's Single source shortest path, All pairs shortest paths- Flyod-
Warshall Algorithm, Topological ordering.
Case study: Analyzing social interactions and influence within a social network.

Learning Resources

Text Books:

1. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, "Fundamentals of Data Structures in C", Publisher - Universities Press, 2nd Edition , 2008, ISBN-13: 978-8173716058, ISBN-10: 8173716056.

2. Reema Thareja, "Data Structures Using C", 2nd Edition, Oxford University Press, ISBN-13: 978-0-19-809930-7 ISBN-10: 0-19-809930-4

Reference Books:

1. Steven S. Skiena, "The Algorithm Design Manual", Springer, 2ndedition, ISBN : 978-1-84800-069-8

2. Yashavant Kanetkar, "Let Us C", 8th Edition, BPB Publications, ISBN: 9788183331777

3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, ISBN: 978-8177583588

4. Aaron M. Tenenbaum, "Data Structures Using C", 2nd Edition, Pearson Education, ISBN: 978813171148

MOOC / NPTEL/YouTube Links: -

1. https://nptel.ac.in/courses/106106133

2. https://nptel.ac.in/courses/106102064

3. https://nptel.ac.in/courses/106103069

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science - 2024 Pattern

PCC-202- AID: Artificial Intelligence		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 30 Marks **End-Semester**: 70 Marks

Prerequisite Courses, if any : Students should have prior knowledge of Mathematics, Probability and statistic ,Programming and Problem Solving

Course Objectives: The course aims to:

1. Introduce students to the fundamental concepts of Artificial Intelligence, its applications, and ethical considerations.

2. To understand Problem Solving using various peculiar search strategies for AI

3. To introduce students to adversarial search strategies used in game-playing AI and familiarize them with constraint satisfaction techniques essential for solving combinatorial problems in AI

4. To acquaint with the fundamentals of knowledge and reasoning

5. To develop a mind to solve real world problems unconventionally with optimality

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

- CO1: **Explain** the fundamentals of AI and its various applications in real-world scenarios.

- CO2: **Build** smart system using different informed search / uninformed search or heuristic approaches

- CO3: **Design** AI systems using adversarial search algorithms and solve problems using constraint satisfaction techniques for structured environments.

- CO4: **Apply** knowledge and reasoning algorithms for real-world problem-solving.

- CO5: **Represent** complex problems with expressive yet carefully constrained language of representation

Course Contents

Unit I - Introduction to AI   (09 Hours)

Introduce to the fundamentals of AI, history, applications, and challenges. Definition and History of AI , Applications and Impact of AI in Various Domains , Types of AI: Narrow AI, General AI, and Super AI , Intelligent Agents, Agents and Environments, Concept of Rationality, Nature of Environments, Structure of Agents.

AI in Problem Solving: State Space Representation , AI Ethics and Challenges

Case studies : AI Applications with demonstration like sentiment analysis, Obstacle detection etc.

Unit II - Problem-solving   (09 Hours)

Solving Problems by Searching, Problem-Solving Agents, Example Problems, Search Algorithms, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions, Search in Complex Environments, Local Search and Optimization Problems

Case Studies : Siemens & GE – Leveraging AI, Big Data, and Robotics in Smart Manufacturing (4IR Context)

Unit III - Adversarial Search and Constraint Satisfaction (09 Hours)

Game Theory, Optimal Decisions in Games, Heuristic Alpha–Beta Tree Search, Monte Carlo Tree Search, Stochastic Games, Partially Observable Games, Limitations of Game Search Algorithms, Constraint Satisfaction Problems (CSP), Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs.

Case Studies : Google DeepMind – AI for Energy Efficiency in Data Centers and Game Playing (e.g., AlphaGo)

Unit IV Knowledge and Reasoning (09 Hours)

Logical Agents, Knowledge-Based Agents, The Wumpus World problem, Propositional Logic: A Very Simple Logic, Propositional Theorem Proving, Effective Propositional Model Checking, Agents Based on Propositional Logic, First-Order Logic, Representation Revisited, Syntax and Semantics of First-Order Logic, Using First-Order Logic, Knowledge Engineering in First-Order Logic.

Inference in First-Order Logic, Propositional vs. First-Order Inference, Unification and First-Order Inference, Forward Chaining, Backward Chaining, Resolution, Knowledge Representation

Case Studies :BBC & Amazon Alexa – AI-Driven Interactive Media with Logic-Based Chatbots

Unit V Planning and Emerging AI Topics (09 Hours)

Automated and Classical Planning, Hierarchical Planning, Planning under Uncertainty, Analysis of Planning Approaches, Limits of AI, Ethics of AI, Future of AI, AI Components ,Introduction of Generative AI (GPT, DALL·E), Explainable AI (XAI), Federated Learning, Edge AI

Case Studies : OpenAI's GPT-4 & ChatGPT – Impacts of Generative AI and Prompt Engineering

Learning Resources

Text Books:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third edition, Pearson, 2003, ISBN :10:0136042597

2. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education(India), 2013, ISBN :978-1-25-902998-1

3. Elaine Rich,Kevin Knight and Nair,"Artificial Intelligence",TMH,ISBN-978-0-07-008770-5

Reference Books:

1. Nilsson Nils J , "Artificial Intelligence: A new Synthesis", Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN:978-1-55-860467-4

2. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley Publishing Company, ISBN: 0-201-53377-4

3. Andries P. Engelbrecht-Computational Intelligence: An Introduction, 2nd Edition-Wiley India-ISBN:978-0-470-51250-0

4. Dr. Lavika Goel, "Artificial Intelligence: Concepts and Applications", Wiley publication, ISBN:97881265

5. Dr.Nilakshi Jain,"Artificial Intelligence,As per AICTE: Making a System Intelligent",Wiley publication, ISBN: 9788126579945

MOOC / NPTEL/YouTube Links: -

1. https://nptel.ac.in/courses/106/102/106102220/

2. https://nptel.ac.in/courses/106/105/106105077/

3. https://nptel.ac.in/courses/106/105/106105078/

4. https://nptel.ac.in/courses/106/105/106105079/

E- Books Links: -

1. https://cs.calvin.edu/courses/cs/344/kvlinden/resources/AIMA-3rd-edition.pdf

2. https://www.cin.ufpe.br/~tfl2/artificial-intelligence-modern-approach.9780131038059.25368.pdf

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science - 2024 Pattern		
PCC-203- AID: Operating System		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 30 Marks **End-Semester**: 70 Marks

Prerequisite Courses, if any : Students should have prior knowledge of

1. Basic Understanding of Computer Systems

2. Fundamentals of Programming Languages

Course Objectives: The course aims to:

1. Design and implementation of scheduling and memory management policies in Operating systems

2. Working of concurrency and locking mechanism in operating systems.

3. I/O management and advanced concepts of Operating Systems.

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

- CO1: **Use** the concepts of virtualization and process management

- CO2: **Analyse** various scheduling algorithms

- CO3: **Discuss** various memory management techniques

- CO4: **Describe** the working of concurrency and locking mechanism in operating systems

- CO5: **Elaborate** I/O management concepts

Course Contents

Unit I - Introduction to Operating System and Process (09 Hours)

Introduction to operating systems, Types of OS, real time OS, the Linux Operating Systems
Process: process abstraction, system calls for process management, process creation: process states, data structures, process execution mechanisms process api, process control and users

Case Study : Windows 11/Linux

Unit II - Scheduling (09 Hours)

Workload assumptions, scheduling metrics, response time, first in, first out (FIFO) shortest job first (SJF), shortest time-to-completion first (STCF), round robin, incorporating I/O, the multi-level feedback queue, the priority boost, attempt, better accounting, multiprocessor scheduling, synchronization, cache affinity, single-queue scheduling multi-queue scheduling, Linux multiprocessor schedulers.

Case Study - Scheduling and Synchronization in xv6

Unit III - Address Spaces   (09 Hours)

Early systems, multiprogramming and time sharing, the address space, virtualization of memory, memory api: types of memory, the malloc() call, the free() call, segmentation, fine-grained vs. coarse-grained segmentation, free-space management, paging, a memory trace, faster translations (TLBs), TLB basic algorithm, TLB issue: context switches, replacement policy, hybrid approach: paging and segments, beyond physical memory: mechanisms, swap space, the page fault, page fault control flow.

Case Study - Linux/Windows Memory Management

Unit IV - Concurrency   (09 Hours)

Concurrency, persistence, Shared data, uncontrolled scheduling, the wish for atomicity, thread api : need of threads, thread creation, thread completion Locks: the basic idea, pthread locks, building a lock, evaluating locks, controlling interrupts, failed attempt, just using

Semaphores: definition, binary semaphores (locks), semaphores for ordering, the producer/consumer (bounded buffer) problem, reader-writer locks, dining philosophers' problem, how to implement semaphores, common concurrency problems.

Case Study : Thread programming Using Pthreads, POSIX

Unit V - I/O Management   (09 Hours)

System architecture, A Canonical device, The Canonical protocol, CPU virtualization, Lowering CPU Overhead with Interrupts, More efficient data movement With DMA, Methods of device interaction, Fitting into the OS: The device driver, Case Study: A simple IDE disk driver, Hard disk drives, files and directories, The fast file system, file system implementation, disk failure modes, handling latent sector error, detecting corruption: the checksum, using checksums

Case Study - I/O Management in Linux/Windows operating system

Learning Resources

Text Books:

1. Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau "Operating Systems: Three Easy Pieces

2. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, ISBN-10: 0-13-380591-3, ISBN-13: 978-0-13-380591-8, 8th Edition

Reference Books:

1. Silberschatz, A, Galvin, P.B, and Gagne, G., "Operating System Principles", Eight Edition, John Wiley & Sons, 2008.

2. Bach Maurice J. "The Design of the UNIX Operating System", Second Edition Prentice Hall of India, 2001

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

E-Book

1. https://repository.dinus.ac.id/docs/ajar/Operating_System.pdf

MOOC/SWAYAM Courses:

1. https://onlinecourses.nptel.ac.in/noc20_cs04/preview

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science - 2024 Pattern

PCC-204- AID: Data Structures Laboratory		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 04 Hours/Week	02	**Term Work** : 25 Marks **Practical :** 50 Marks

Companion Course if any: Data Structures

Course Objectives: The course aims to:

1. To understand practical implementation and usage of non- linear data structures for solving problems of different domain.

2. To strengthen the ability to identify and apply the suitable data structure for the given real world problems.

3. To analyze advanced data structures including hash table, dictionary, trees, graphs, sorting algorithms and file organization.

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

- CO1: **Use** the ADT/libraries and hash tables to design algorithms for specific problem.

- CO2: **Choose** most appropriate data structures for graphical solutions of the problems.

- CO3: **Apply** non linear data structures to solve real world complex problems.

- CO4: **Implement** algorithm design techniques for indexing, sorting, multi-way searching.

- CO5: **Analyze** the efficiency of most appropriate data structure for creating efficient solutions for engineering design situations.

Course Contents

Guidelines for Instructor's Manual

The instructor's manual/Lab 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), curriculum of course, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/guidelines, references.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments 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. Students programs maintained on cloud or college server by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory for accreditation purpose.

Guidelines for Laboratory/Term Work Assessment

Continuous assessment of laboratory work should be done based on overall performance and Laboratory assignments performance of student. Each Laboratory assignment assessment should be assigned grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each Laboratory 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 needs 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 and distribute them among batches of students.
It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of Hungarian notation, proper indentation and comments. Use of open source software is to be encouraged. In addition to these, instructors may assign one real life application in the form of a mini-project based on the concepts learned. Instructors may also set one assignment or mini-project that is suitable to respective branch beyond the scope of the syllabus.

Set of suggested assignment lists is provided in groups- A, B, C, D, and E. Each student must perform at least 9 assignments (All assignment for group A are compulsory, 2 from group B, 2 from group C, 1 from group D and 1 from group E.)

- All assignments should be implemented in C/C++ language.

- Operating System Recommended: 64-bit Open Source Linux or its derivatives

- Programming Tools Recommended: Open Source C compiler such as GCC/G++.

- Development environments or text editors like Visual Studio Code, Geany, Code::Blocks, or terminal-based editors like Vim or Emacs.

Guidelines for Practical Examination

Both internal and external examiners should jointly set problem statements. 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 test the student's for advanced learning, understanding of the fundamentals, effective and efficient implementation. So encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising start of the student's academics.

Learning Resources

Virtual Laboratory:

1. https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html

Suggested List of Laboratory Experiments/Assignments

Sr. No.	Group A - (All)
1	Write menu based program-
	a) Write a program to store roll numbers of student in array who attended a training program in random order. Write a function for searching whether a particular student attended a training program or not, using Linear search.
	b) Write a program to store roll numbers of student array who attended training programs in sorted order. Write a function for searching whether a particular student attended a training program or not, using Binary search.
2	Write a program to store the first year percentage of students in an array. Write function for sorting array of floating point numbers in ascending order using - Selection Sort - Bubble sort and display top five scores
3	Consider the telephone book database of N clients. Make use of a hash table implementation to quickly look up a client's telephone number. Make use of linear probing, double hashing and quadratic collision handling techniques.
	Group B - Assignments (Any TWO)
4	The Department of Computer Engineering has a student's club named 'Pinnacle Club'. Students of the second, third and final year of the department can be granted membership on request. Similarly one may cancel the membership of the club. First node is reserved for the president of the club and the last node is reserved for the secretary of the club. Write a program to maintain club member's information using singly linked lists. Store student PRN and Name. Write functions to: a) Add and delete the members as well as president or even secretary. b) Compute total number of members of club c) Display members d) Two linked lists exist for two divisions. Concatenate two lists.
	OR
	Second year Computer Engineering class, set A of students like Vanilla Ice-cream and set B of students like butterscotch ice-cream. Write a program to store two sets using a linked list. compute and display- a) Set of students who like both vanilla and butterscotch b) Set of students who like either vanilla or butterscotch or not both c) Number of students who like neither vanilla nor butterscotch
5	The ticket booking system of Cinemax theater has to be implemented. There are 10 rows and 7 seats in each row. Doubly linked list has to be maintained to keep track of free seats in rows. Assume some random booking to start with. Use an array to store pointers (Head pointer) to each row. On demand a) The list of available seats is to be displayed b) The seats are to be booked c) The booking can be cancelled.
	OR
	Write a program to implement doubly linked list a) Display free slots b) Book appointment c) Sort list based on time d) Cancel appointment (check validity, time bounds, availability) e)Sort list based on time using pointer manipulation (Unit II)
	Group C- Assignments (Any TWO)
6	In any language program mostly syntax error occurs due to unbalancing delimiter such as (), {}, []. Write a program using stack to check whether a given expression is well parenthesized or not.
	OR

	Implement a program for expression conversion as infix to postfix and its evaluation using stack based on given conditions: 1. Operands and operators, both must be single characters. 2. Input Postfix expression must be in a desired format. 3. Only ","," and operators are expected.
7	Pizza parlor accepting maximum M orders. Orders are served on a first come first served basis. Queues are frequently used in computer programming, and a typical example is the creation of a job queue by an operating system. If the operating system does not use priorities, then the jobs are processed in the order they enter the system. Write a program for simulating job queue. Write functions to add jobs and delete jobs from the queue.
	OR
	Queues are frequently used in computer programming, and a typical example is the creation of a job queue by an operating system. If the operating system does not use priorities, then the jobs are processed in the order they enter the system. Write C program for simulating job queue. Write functions to add job and delete job from the queue.
	Group D- Assignments (Any ONE)
8	Beginning with an empty binary search tree, Construct a binary search tree by inserting the values in the order given. After constructing a binary tree - i. Insert new node ii. Find number of nodes in longest path from root iii. Minimum data value found in the tree iv. Change a tree so that the roles of the left and right pointers are swapped at every node v. Search a value.
	OR
	A Dictionary stores keywords and its meanings. Provide facility for adding new keywords, deleting keywords, updating values of any entry. Provide a facility to display whole data sorted in ascending/ Descending order. Also find how many maximum comparisons may require for finding any keyword. Use Binary Search Tree for implementation.
	Group E - Assignments (Any ONE)
9	There are flight paths between cities. If there is a flight between city A and city B then there is an edge between the cities. The cost of the edge can be the time that flight takes to reach city B from A or the amount of fuel used for the journey. Represent this as a graph. The node can be represented by the airport name or name of the city. Use adjacency list representation of the graph or use adjacency matrix representation of the graph. Check whether the graph is connected or not.
	OR
	You have a business with several offices; you want to lease phone lines to connect them up with each other; and the phone company charges different amounts of money to connect different pairs of cities. You want a set of lines that connects all your offices With a minimum total cost. Solve the problem by suggesting appropriate data structures.
	Group F - Assignments
10	Design a mini project which will use the different data structure to show the use of specific data structure and efficiency (performance) of the code.

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science - 2024 Pattern		
PCC-205- AID: Artificial Intelligence Laboratory		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	01	**Term Work** : 25 Marks **Oral :** 25 Marks

Companion Course if any: Artificial Intelligence

Course Objectives: The course aims to:

1. To introduce fundamental concepts and techniques in Artificial Intelligence.

2. To enable students to implement key AI algorithms for search, reasoning, and learning.

3. To develop practical skills in solving real-world problems using AI.

4. To provide foundational knowledge in neural networks and decision-making systems.

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

- CO1: **Apply** rule-based systems and search algorithms (BFS, DFS, A*) to solve structured problem-solving tasks.

- CO2: **Design** and implement solutions for constraint satisfaction problems using backtracking and constraint propagation.

- CO3: **Develop** intelligent agents for decision-making in games using Minimax and Alpha-Beta Pruning techniques.

- CO4: **Analyze** basic neural network models for classification tasks, including the use of activation functions.

<div align="center">Course Contents</div>

Guidelines for Instructor's Manual

The instructor's manual/Lab 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), curriculum of course, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/guidelines, references.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments 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. Students programs maintained on cloud or college server by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory for accreditation purpose.

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Continuous assessment of laboratory work should be done based on overall performance and Laboratory assignments performance of student. Each Laboratory assignment assessment should be assigned grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each Laboratory 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 needs 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 and distribute them among batches of students.

Suggested List of Laboratory Experiments/Assignments

Sr.	Practical Assignments
1	Building an Expert System Using Rule-Based Systems - Objective: Develop an Expert System that provides simple decision-making.
2	Implementing AI Search Algorithms (BFS & DFS) - Maze Solver Objective: Solve AI search problems using Graph Search Algorithms.
3	Implementation of A* algorithm Objective: Solve AI search problems using Graph Search Algorithm.
4	Implement a solution for Constraint Satisfaction Problem (CSP) Objective: To implement a CSP-based solution for solving real-world problems like Map Coloring, Sudoku, or Timetable Scheduling using backtracking with constraint propagation.
5	Implementing Minimax Algorithm Objective: Understand and implement the basic Minimax algorithm for two-player deterministic games.
6	Minimax with Alpha-Beta Pruning Objective: Enhance Minimax using Alpha-Beta pruning to reduce computation time.
7	Assignment and practice of ChatGPT and its usage
8	Assignment and practice of SORA
9	Assignment and practice of AI Image Genrator
10	Assignment and practice of Prompt Engineering to craft effective prompts.

Learning Resources

Reference Books

1. Nilsson Nils J , "Artificial Intelligence: A new Synthesis", Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN:978-1-55-860467-4

2. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley Publishing Company, ISBN: 0-201-53377-4

3. Andries P. Engelbrecht-Computational Intelligence: An Introduction, 2nd Edition-Wiley India-ISBN:978-0-470-51250-0

4. Dr. Lavika Goel, "Artificial Intelligence: Concepts and Applications", Wiley publication, ISBN:97881265

5. Dr. Nilakshi Jain,"Artificial Intelligence,As per AICTE: Making a System Intelligent",Wiley publication, ISBN: 9788126579945

e-Books

1. https://cs.calvin.edu/courses/cs/344/kvlinden/resources/AIMA-3rd-edition.pdf

2. https://www.cin.ufpe.br/~tfl2/artificial-intelligence-modern-approach.9780131038059.25368.pdf

MOOC

1. https://nptel.ac.in/courses/106/102/106102220/

2. https://nptel.ac.in/courses/106/105/106105077/

3. https://nptel.ac.in/courses/106/105/106105078/

4. https://nptel.ac.in/courses/106/105/106105079/

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science - 2024 Pattern		
MDM-221-AID : Digital Electronics and Logic Design		
Teaching Scheme	Credits	Examination Scheme
Theory : 02 Hours/Week	02	**CCE** : 30 Marks **End-Semester**: 70 Marks

Prerequisite Courses, if any :

1. Basic Electronics Engineering

Companion Course if any: NA

Course Objectives: The course aims to:

1. To Explain different number systems, digital circuit design and the K-map minimization techniques.

2. To Construct the design procedure of combinational and sequential circuits.

3. To Understand the historical and architectural evolution of Intel microprocessors.

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

- CO1: Simplify Boolean expressions using Karnaugh Maps (K-Maps) for efficient logic design.

- CO2: Develop Strong understanding of the theoretical and Practical aspects of digital logic, codes and combinational circuits

- CO3: Implement sequential circuits by applying knowledge of flip-flops, counters, and state machines

- CO4: Interpret various processor architectures and their use in real-time AI applications.

- CO5: Analyze and compare different AI-focused processors.

Course Contents

Unit I - Introduction to Digital Systems (06 Hours)

Number systems: Binary, Decimal, Octal and Hexadecimal Number system, conversion of one number system to another, representation of signed number- sign magnitude representation, 1's complement and 2's complement form, addition and subtraction of two binary numbers, Fixed point representation of a numbers, standard representation for logic functions, Minimization of Boolean function using K-map (up to 4 variables), Minimization of SOP and POS using K-map.

Case Study: Number systems use in networking and IP addressing, Digital locks

Unit II - Combinational Logic Design (06 Hours)

Classification of Codes : Weighted and Non-weighted Codes, Error Detecting and Correcting Codes ,Self-complementary codes, Reflective Codes (Binary , BCD, Gray code and Excess-3 code)

Code Conversion : Binary to Gray and Gray to Binary code conversion,BCD to Excess-3 Half- Adder, Full Adder, Half Subtractor, Full Subtractor, 4 Bit Parallel Adder, BCD adder,Multiplexers (MUX), De-multiplexers (DEMUX) , Implementation of SOP and POS using MUX, DMUX,Magnitude Comparator

Case Study :BCD to 7-segment display Controller

Unit III - Sequential Circuits   (06 Hours)

Flip-Flop: SR, JK, D,T, MSJK, Truth Tables and Excitation tables, Conversion of Flip-Flop ,Shift Registers, Bidirectional Shift Register, Universal Shift Register, Ring Counter ,Johnson Counter

Counters: Asynchronous Counter, Synchronous Counter, BCD Counter, Modulus of the counter (IC 7490), Presettable Counter, Synchronous sequential circuits : Moore Circuit, Mealy Circuit, State Diagram, State table, State Reduction ,State Assignment

Case study: A Digital Combination Lock, Electronics Voting machine (EVM)

Unit IV - Microprocessor Fundamentals   (06 Hours)

Evolution of Intel Microprocessors, Overview of microprocessor vs microcontroller. Intel x86 (Pentium): Architecture, registers, instruction types. ARM Cortex architecture: RISC principles, use in mobile AI. NVIDIA Jetson: GPU-based AI processing, use in robotics and edge AI. Simple assembly and C-code-based examples.

Case study : Smart Object Counter with AI Edge Inference using NVIDIA Jetson and ESP32 Communication

Unit V - Emerging Processors for AI   (06 Hours)

Introduction to AI-focused processors: CPU(Central Processing Unit), GPU(Graphics Processing Unit), TPU(Tensor Processing Unit), NPU(Neural Processing Unit), VPU(Vision Processing Unit).

Comparison: Intel Core Ultra, Apple M3, NVIDIA RTX, Google TPU, AMD Ryzen AI, Qualcomm Hexagon. Concepts of Edge AI & Cloud AI processing. Heterogeneous computing (CPU+GPU+NPU). Benchmarks& Metrics: FLOPS, TOPS, latency, power efficiency

Case study: Face Detection Door Lock – Choosing Between Jetson, ESP32, and ARM Cortex ; Voice-Controlled Fan: ESP32 vs Mobile NPU

Learning Resources

- **Text Books:**

1. Modern Digital Electronics by R.P.Jain, 4th Edition, ISBN 978-0-07-06691-16 Tata McGraw Hill

2. Digital Logic and Computer Design by Moris Mano, Pearson , ISBN 978-93-325-4252-5

3. G.K.Kharate," Digital Electronics", Oxford Press,ISBN-10:0198061838

4. B.Ram ,— Computer Fundamentals Architecture and Organization , 3rd Edition ,New Age International Limited

5. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International

6. Barry B. Brey, "The Intel Microprocessors (8th Edition or later)", Pearson Education.

7. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Elsevier Publisher

- **Reference Books:**

1. John Yarbrough, ⸺Digital Logic applications and Design, Cengage Learning, ISBN – 13: 978-81- 315-0058-3

2. D. Leach, Malvino, Saha, ⸺Digital Principles and Applications||, Tata McGraw Hill, ISBN – 13:978-0-07-014170-4

3. Anil Maini, ⸺Digital Electronics: Principles and Integrated Circuits||, Wiley India Ltd, ISBN:978-81-265-1466-3

4. Norman B & Bradley, ⸺Digital Logic Design Principles, Wiley India Ltd, ISBN:978-81-265-1258

5. Safwat Zaky,⸺Computer Organization , 5th edition Tata McGraw Hill

6. William Stallings,⸺Computer Organization & Architecture Designing for Performance, Pearson

7. Lyla B.Das,⸺ The X86 Microprocessors (Architecture, Programming and Interfacing 8086 to Pentium) Pearson

8. Douglas Hall, ⸺Microprocessor and Interfacing ||, Mc Graw Hill Education

- **e-Books:**

1. https://link.springer.com/book/10.1007/978-3-030-36196-9

2. https://www.mheducation.co.uk/ebook-fundamentals-of-digital-logic-9780077144227-emea

- **MOOC / NPTEL/YouTube Links: -**

1. Digital Circuits, by Prof.SantanuChattopadhyay , IIT Kharagpur https://swayam.gov.in/nd1_noc19_ee5

2. Digital Circuits and Systems ,Prof. S. Srinivasan , IIT Madras https://nptel.ac.in/courses/117/106/117

3. Microprocessors and Interfacing, by Prof Shaikh Rafi Ahamed, IIT Guwahati.https://onlinecourses.npte

- **YouTube/Video Links:**

1. https://www.youtube.com/watch?v=CL3ups78jrs

2. https://www.youtube.com/watch?v=ibQBb5yEDlQ

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science - 2024 Pattern		
EEM-231- AID : Entrepreneurship Development		
Teaching Scheme	Credits	Examination Scheme
Practical : 2 Hours/Week **Tutorials** : 1 Hour/Week	01 01	**Term Work** : 25 Marks

Course Objectives: The course aims to:

1. Introduce the fundamental principles of entrepreneurship, forms of business organizations, and the startup ecosystem.

2. Enable students to identify, evaluate, and select viable business opportunities using structured techniques.

3. Familiarize students with business models, financial planning, and market validation strategies.

4. Expose students to key marketing strategies, customer acquisition techniques, and branding essentials for startups

5. Develop students' entrepreneurial mindset and their ability to communicate and pitch business ideas effectively using structured storytelling techniques

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

- CO1: **Describe** the role of entrepreneurship in economic growth and the startup ecosystem.

- CO2: **Apply** creative techniques to viable business ideas based on customer needs.

- CO3: **Develop** a basic business model using tools like the Business Model Canvas through market research.

- CO4: **Implement** basic marketing strategies for startups.

- CO5: **Deliver** a concise business pitch using storytelling and effective communication techniques.

Course Contents

Unit I - Introduction to Entrepreneurship (03 Hours)

Entrepreneurship: Definition and evolution, Role of entrepreneurship in economic development , Role in job creation, GDP, and innovation.

Characteristics of an Entrepreneur: Key traits: Risk-taking, innovation, pro-activeness, Leadership, perseverance, and resilience

Types of Entrepreneurships: Startup entrepreneurship, Social entrepreneurship, Intrapreneurship (corporate entrepreneurship), Lifestyle and small business entrepreneurship, Forms of Business Organization – Sole proprietorship, partnership, private limited, public limited.

Entrepreneurial Mindset: Growth mindset and adaptability, Creativity and problem-solving, Opportunity recognition and initiative-taking

Overview of the Startup Ecosystem: Key stakeholders: Incubators, accelerators, angel investors, VCs, Government support schemes (Startup India, Atal Innovation Mission, etc.), Global vs. Indian startup ecosystems

Case Study:

1. Ritesh Agarwal – Founder of OYO Rooms (India)

2. Falguni Nayar – Founder of Nykaa (India)

3. Nandan Nilekani – Co-founder of Infosys & Architect of Aadhaar (India) etc.

Unit II -Idea Generation & Opportunity Recognition (03 Hours)

Creativity Techniques for Idea Generation: Definition and importance of creativity in entrepreneurship. Brainstorming: Rules of effective brainstorming. Individual vs. group brainstorming. Mind Mapping: Visual idea structuring using central themes and branches. Tools (manual and digital) for mind mapping.

Understanding Customer Needs and Pain Points: Customer pain points and their identification, Problem-solution fit: Linking pain points to possible solutions. Observational techniques, user interviews, and empathy mapping.

Evaluating Opportunities: Difference between an "idea" and an "opportunity." Basic filters: Desirability, feasibility, and viability. Tools: SWOT Analysis, Opportunity Matrix, Industry trends, market gaps.

Case Study : Analyzing how "Dunzo" or "BigBasket" identified urban pain points and How "Zerodha" scaled in India with a digital-first approach

Unit III - Business Model Development (03 Hours)

Introduction to Business Model Canvas: Definition and purpose of a business model, Overview of the Business Model Canvas by Osterwalder, Benefits of using BMC for startups.

Key Components of BMC: Value Proposition: Defining what unique value the product/service offers. Addressing customer pain points. Customer Segments: Identifying target customers. Creating customer personas Revenue Models: Direct sales, subscriptions, freemium, licensing, etc.

Basic Market Research for Validation: Importance of market research in early-stage business development. Designing effective surveys and customer feedback forms. Conducting basic interviews and analyzing responses. Introduction to MVP (Minimum Viable Product) and feedback loops.

Case study: Map the BMC for a well-known startup (e.g., Uber or Zomato).

Unit IV - Marketing Strategies & Customer Acquisition (03 Hours)

Basics of Branding and Positioning: Introduction to Brand – Elements of brand identity: name, logo, voice, tone, and values. Positioning – How to create a unique space in the customer's mind. Positioning maps, Value-based positioning vs. competitor-based positioning Startup Branding Challenges – Limited budget, building trust, clarity in messaging.

Costing & Pricing Strategies – Fixed vs. variable costs, break-even analysis.

Introduction to Digital Marketing: Distribution Channels: Traditional vs. digital distribution. Social Media Marketing: Platforms overview (Instagram, LinkedIn, Facebook, X/Twitter) Creating a content strategy and calendar Organic vs. paid reach

Search Engine Optimization (SEO): Basics of how search engines work, Keyword research and content optimization, On-page vs. off-page SEO Importance of Digital Presence – Website essentials, blogs, and analytics tools.

Customer Acquisition Strategies: Understanding the Customer Journey – Awareness, interest, decision, action. Early-Stage Customer Acquisition Tactics: Word-of-mouth & referrals, Influencer marketing (micro-influencers), Email marketing basics, building a landing page and collecting leads

Case Studies :

1. Zomato – Branding & Positioning in a Competitive Market

2. Mamaearth – Digital-First Customer Acquisition

3. Nykaa – Customer Segmentation and Channel Strategy

Unit V - Pitching & Business Communication   (03 Hours)

Crafting an Elevator Pitch: Definition and purpose, Key elements: Problem, solution, value proposition, target audience, Delivery tips: Clarity, brevity, confidence

Storytelling & Communication: Importance of Storytelling in Business, Structure of a Business Story: Setup, Conflict, Resolution. Communication Skills: Verbal and Non-verbal

Overview of Funding Sources: Public & private capital sources, venture capital, debt financing. Bootstrapping: Meaning, benefits, and risks, Angel investors: Role, expectations, approach, Brief on incubators, government schemes, crowdfunding.

Case study:

1. Shark Tank India – Pitch Analysis (Any Season)

2. Airbnb – The Original Pitch Deck

3. Dropbox – Storytelling Through Demonstration

4. Dunzo – Investor Pitch Evolution

Learning Resources

Text Books:

1. Bygrave, W.D., Zacharakis, A., & Corbett, A.C. Entrepreneurship, 6th Edition, Wiley, 2025. ISBN: 9781394262809.

2. Drucker, Peter F. Innovation and Entrepreneurship: Practice and Principles, Reprint Edition, Harper Business, 2006. ISBN: 9780060851132.

3. Osterwalder, Alexander & Pigneur, Yves. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, 1st Edition, Wiley, 2010. ISBN: 9780470876411.

Reference Books:

1. Ries, Eric. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, 1st Edition, Crown Business, 2011. ISBN: 9780307887894.

2. Kawasaki, Guy. The Art of the Start 2.0: The Time-Tested, Battle-Hardened Guide for Anyone Starting Anything, Portfolio (Penguin Random House), 2015. ISBN: 9781591847847.

MOOC / NPTEL/YouTube Links: -

1. Entrepreneurship Essentials By Prof. Manoj Kumar Mondal IIT Kharagpur
https://onlinecourses.nptel.ac.in/noc20_ge08/preview

2. Entrepreneurship By Prof. C Bhaktavatsala Rao
IIT Madras https://onlinecourses.nptel.ac.in/noc21_mg70/preview

3. https://onlinecourses.nptel.ac.in/noc20_mg35

4. https://www.coursera.org/learn/entrepreneur-guide-beginners

5. https://wadhwanifoundation.org/

YouTube/Video Links

1. https://www.youtube.com/@wadhwani-foundation/videos

List of Assignments

No	Title	Objective	Description
1	Entrepreneurial Mindset Reflection	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.	**Write a reflective essay** (500–600 words) based on 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.

2	Idea Generation Challenge	To foster creativity, structured brainstorming, and the ability to identify potential business opportunities based on real-world problems.	**Generate 10 Business Ideas** Use any structured brainstorming technique Ideas can be tech-based, social impact, service-based, or product-based 2. Select One Idea- Choose the most promising idea from your list 3. Write a 1-page Concept Summary, include the following: • Problem Identified: Describe the specific problem or pain point your idea addresses. • Solution Overview: Briefly describe your business idea. • Target Audience: Identify the group of people or organizations that would benefit. • Market Potential: Discuss the viability and scalability of the idea.
3	Business Model & Customer Validation	To help students develop a clear, structured business model and test its assumptions through customer conversations. The goal is to learn how to validate ideas through real-world feedback and refine the business concept accordingly.	**Part A: Business Model Canvas** 1. Choose a business idea (from Assignment 2 or a new one). 2. Create a Business Model Canvas with all 9 key blocks: o Customer Segments o Value Propositions o Channels o Customer Relationships o Revenue Streams o Key Resources o Key Activities o Key Partnerships o Cost Structure 3. Present the BMC in visual or tabular format.

			Part B: Customer Interviews & Insights 1. Identify 2–3 potential customers from your target segment. 2. Conduct brief interviews (5–10 minutes each) to gather insights on: o Their pain points o Their reaction to your proposed solution o Willingness to pay or use your product/service 3. Summarize findings in a 1–1.5 page report that includes: o Key customer quotes or paraphrased insights o A revised Value Proposition or Customer Segment block (if needed) o A short reflection: key learnings and potential changes to your idea
4	Business Launch Plan – Marketing & Financial Snapshot	To develop a practical understanding of how marketing stratey and financial planning go hand-in-hand in launching a startup. Students will define a basic marketing campaign and align it with estimated costs, pricing, and projected revenue.	You are preparing to launch your business idea. Prepare a combined Marketing and Financial Snapshot including the following **Part A: Marketing Campaign Plan** • Define your target market by identifying primary customers. • Design a mini-campaign using one or more of the following channels: Social media (e.g., Instagram, LinkedIn) Print/digital flyers Email marketing • Describe the campaign content, including the message or offer to be promoted. • Optionally, create 1–2 sample marketing materials. • Write a 300-word explanation outlining your marketing strategy and expected impact.
			Part B: Financial Snapshot 1. Startup Costs – Estimate your initial costs (fixed + variable) 2. Pricing Strategy – State your pricing model and justification 3. Break-even Analysis – Basic cost vs. sales estimate 4. 6-Month Revenue Projection – Expected sales and income 5. Format: Use a simple table or spreadsheet (optional)

5	Elevator Pitch Video	To help students develop confidence and clarity in presenting their business idea in a short, compelling format. The exercise simulates real-world investor or networking scenarios where entrepreneurs must grab attention quickly.	**Prepare a 90-second elevator pitch for your business idea** (the same or refined idea used in earlier assignments). Your pitch should cover the following elements: o The Problem – Problem Identification o The Solution – Description of your product/service. o Value Proposition – The unique value proposition. o Target Audience – Audience for your idea. o Call to Action – E.g. request for support, funding, feedback, etc. **Deliver Your Pitch:** o Record a video and submit it with written version of your pitch. o Ensure clear speech, confident body language (for video), and persuasive tone. **Reflection (Short Write-up):** o Share what you learned about communicating your idea o Describe challenges or rewards you experienced in the process

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science - 2024 Pattern

VEC-232-AID: Universal Human Values and Professional Ethics		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week	02	**CCE:** 15 Marks **End-Semester Exam**: 35 Marks

Prerequisite Courses, if any :

1. Student Induction Program (SIP)

Course Objectives: The course aims to:

1. To help the students develop a holistic, humane world-vision, and appreciate the essential complementarity between values and skills to ensure mutual happiness and prosperity

2. To elaborate on 'Self-exploration' as the process for Value Education

3. To facilitate the understanding of harmony at various levels starting from self and going towards family and society.

4. To elaborate on the salient aspects of harmony in nature and the entire existence

5. To explain how the Right understanding forms the basis of Universal human values and definitiveness of Ethical human conduct.

6. To provide the vision for a holistic way of living and facilitate transition from chaotic life to an orderly life.

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

1. **Recognize** the concept of self-exploration as the process of value education and see they have the potential to explore on their own right.

2. **Explore** the human being as the coexistence of self and body to see their real needs / basic aspirations clearly.

3. **Explain** relationship between one self and the other self as the essential part of relationship and harmony in the family.

4. **Interpret** the interconnectedness, harmony and mutual fulfilment inherent in the nature and the entire existence.

5. **Draw** ethical conclusions in the light of Right understanding facilitating the development of holistic technologies production systems and management models.

Course Contents

Unit I - Introduction to Value Education (07 Hours)

(i) Understanding Value Education

(ii) Self-exploration as the Process for Value Education

(iii) Continuous Happiness and Prosperity - the Basic Human Aspirations and their Fulfilment

(iv) Right Understanding, Relationship and Physical Facility

(v) Happiness and Prosperity - Current Scenario

(vi) Method to Fulfil the Basic Human Aspirations

Unit II - Harmony in the Human Being (07 Hours)

(i) Understanding Human being as the Co-existence of the Self and the Body

(ii) Distinguishing between the Needs of the Self and the Body

(iii) The Body as an Instrument of the Self

(iv) Understanding Harmony in the Self

(v) Harmony of the Self with the Body

(vi) Programme to Ensure self-regulation and Health

Unit III -Harmony in the Family and Society   (08 Hours)

(i) Harmony in the Family - the Basic Unit of Human Interaction "Trust' - the Foundational Value in Relationship

(ii) 'Respect' - as the Right Evaluation

(iii) Values in Human-to-Human Relationship

(iv) Understanding Harmony in the Society

(v) Vision for the Universal Human Order

Unit IV -Harmony in the Nature (Existence)   (08 Hours)

(i) Understanding Harmony in the Nature

(ii) Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature

(iii) Realizing Existence as Co-existence at All Levels

(iv) The Holistic Perception of Harmony in Existence

(v) Professional Ethics in the light of Right Understanding

(vi) Strategies for Transition towards Value-based Life and Profession

Learning Resources

Text Books:

1. A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, GP Bagaria, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-7-3 (Printed Copy), 978-81-957703-6-6 (e-book)

2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, GP Bagaria, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-5-9 (Printed Copy), 978-81-957703-0-4 (e-Book)

Reference Books:

1. P. L. Dhar, R. R. Gaur, 1990, Science and Humanism, Commonwealth Publishers.

2. A. Nagaraj, 1999, Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak

3. B. P. Banerjee, 2005, Foundations of Ethics and Management, Excel Books.

4. A. N. Tripathy, 2003, Human Values, New Age International Publishers.

5. E. G. Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press

6. B. L. Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

7. M. Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics and Human Values, Eastern Economy Edition, Prentice Hall of India Ltd.

8. M. K. Gandhi, "The Story of my Experiments with Truth", Discovery Publisher

MOOC / NPTEL/YouTube Links: -

1. Swayam Course on "Understanding Human Being Nature and Existence Comprehensively" by Dr. Kumar Sambhav, Director, UP Institute of Design (UPID), Noida. https://onlinecourses.swayam2.ac

2. NPTEL Course on "Exploring Human Values: Visions of Happiness and Perfect Society" by Prof. A. K. Sharma, Department of Humanities and Social Sciences, IIT Kanpur. https://nptel.ac.in/courses/1

E-Resources: -

1. https://fdp-si.aicte-india.org/download.php#1/

2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science - 2024 Pattern

CEF-241- AID : Community Engagement Project		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 04 Hours/Week	02	**Term Work :** 25 Marks **Oral /Presentation :** 25 Marks

Prerequisite : Students should have prior knowledge of

1. Basic understanding of social and ethical responsibilities

2. Teamwork and communication skills acquired in prior coursework or group activities

3. Familiarity with problem-solving methodologies and project planning

4. Conversation in local language

Companion Course :

- CEP is an experiential learning approach that combines education, learning, community development, and meaningful community service.

- Project involves students in community development and service activities and applies the experience to personal and academic development.

- The targeted contribution of college students to the village/local development will benefit the community.

- The college has an opportunity to help students become more socially conscious and responsible while simultaneously becoming a socially conscious organization.

Course Objectives: The course aims to:

1. Establish a mutually beneficial relationship between the college and the community

2. Opportunities to engage with their local community, fostering empathy, teamwork, and problem-solving skills while contributing positively to their surroundings.

3. An understanding of the challenges faced by the local community and the role of engineering in addressing those challenges.

4. The ability to apply technical knowledge and skills to design solutions or interventions that create a positive impact on the community.

5. The skills to evaluate and critically analyze the outcomes of their engagement activities, deriving actionable insights for sustainable impact

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

1. Identify and Analyze local community needs and challenges by engaging with stakeholders and evaluating real-world problems.

2. Design and Implement practical, creative, and context-specific solutions using engineering principles to address community issues.

3. Reflect and Evaluate the effectiveness of their interventions and articulate lessons learned through reports and presentations.

<div align="center">Course Contents</div>

Implementation

- A group of 3 to 4 students could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay/college premise.

- Each group /practical batch is allotted to a faculty member of the department as a mentor.

- A division of 60 students can have 3 batches of minimum 20 students. Practical load of 4 hours to be allocated to each batch.

- The group of students will be associated with a government official / village authorities /NGOs etc. concerned, allotted by the district administration, during the duration of the project.

- The Community Engagement Project should be different from the regular programmes of NSS/NCC/Gr Club/Hobby Clubs, Special Interests Groups etc

- An activity book has to be maintained by each of the students to record the activities undertaken/involved and will be countersigned by the concerned mentor/HoD.

- Project report shall be submitted by each student/group of students.

- An internal evaluation shall also be conducted by a committee constituted by the HoD. Evaluation to be done based on the active participation of the student and marks could be awarded by the mentor/HoD.

- Students groups can conduct an awareness programme on Health and Hygiene or in Organic Farming or in Fisheries or in advocating prohibition of liquor or about renewable energy, e-waste management or any other activity in an area of their studies and as per his/her aptitude.

- Oral Examination shall consist of presentation and demonstration of the project work carried out by the project groups.

Suggestive list of topics under Community Engagement Project

The below lists are not exhaustive and open for HoD's or mentors to add, delete or modify. It is expected that the focus should be on specific local issues in their nearby areas.
The students are expected to carry out these projects with involvement, commitment, responsibility and accountability. The mentors of a student/group of students shall

- 1. Use/ miss-use of cell phones

- 2. Career orientation of youth

- 3. Water facilities and drinking water availability

- 4. Health and hygiene of the school going students, home makers and old personals

- 5. Health intervention and awareness programmes

- 6. Horticulture

- 7. Herbal and Nutrition

- 8. Traditional and Modern health care methods

- 9. Food habits

- 10. Air /Sound /Water pollution

- 11. Plantation and Soil protection

- 12. Renewable energy and Solar Systems

- 13. Yoga awareness and practice

- 14. Health care awareness programmes and their impact

- 15. Organic farming

- 16. Food adulteration

- 17. Incidence of Diabetes and other chronic diseases

- 18. Blood groups and blood levels

- 19. Chemicals in daily life

- 20. Music and dance

- 21. Women education and empowerment

Project Scope

- Conduct workshops or awareness drives on topics like digital literacy, environmental sustainability, mental health, or career planning for local stakeholders.

- Develop a simple prototype or solution that addresses a real-world problem (e.g., a water-saving device, simple mobile apps, or tools for community use).

- Organize clean-up drives, tree plantations, recycling campaigns, or energy conservation initiatives.

- Promote health through awareness programs on hygiene, nutrition, and exercise.

- Teach basic computer or technical skills to students, staff, or the community

Proposal Submission

CEP Group should Submit a two-page project proposal, preferably prior to the term commencement outlining the following:-

- Title of the project

- Aim, Objective and expected outcome

- Plan of execution (timeline and activities).

- Place of the CEP and involvement of any local authority, NGP

- Required resources (if any).

- Get approval from the designated faculty mentor.

Learning Resources

Text Books:

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

MOOC / NPTEL/YouTube Links:

1. NPTEL course: Ecology and Society, https://onlinecourses.nptel.ac.in/noc20_hs77/preview

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

Savitribai Phule Pune University, Pune

Maharashtra, India

SE - Artificial Intelligence and Data Science

Semester IV

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science - 2024 Pattern

PCC-251- AID: Database Management Systems		
Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hours/Week	03	**CCE** : 30 Marks **End-Semester:** 70 Marks

Prerequisite Courses:

1. Discrete Mathematics, Data Structures and Algorithms

Course Objectives: The course aims to:

1. To introduce the fundamental concepts of Database Management Systems.

2. To learn Database query languages and transaction processing.

3. To teach Systematic database design approaches.

4. Use of scalable, flexible databases for Big Data.

5. Advances in database technologies and applications.

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

- CO1: **Design** Database Management Systems using ER models.

- CO2: **Execute** database queries using SQL and PL/SQL.

- CO3: Normalize database designs using normal forms.

- CO4: **Apply** transaction management concepts to real-time scenarios.

- CO5: **Use** NoSQL databases for handling unstructured data.

Course Contents

Unit I - Foundations of Data Management and ER Model (09 Hours)

Introduction, Purpose of DBMS, Database Applications, Data Models, DBMS Architecture, DBMS languages. Database Design and ER Model: Entities, Attributes, Relationships, Keys, Constraints, ER Diagrams, Design Process, Design Issues. Extended ER features, converting ER/EER diagrams to relational tables

Case Study: Analyze and design a database using the ER model for a real-time application and convert it to relational tables.

Unit II - Smart Data Querying with SQL & PL/SQL (09 Hours)

SQL: Data types, DDL, DML, DCL, and TCL commands (Create User, Grant, Revoke Queries) Tables: Create, Insert, Update, Delete, Alter, Drop, SELECT, Joins, Views (Create, Update, Drop), Aggregation functions, Set operations, SQL Operators, SQL Predicates, Nested queries.PL/SQL: Stored procedures, functions, triggers, assertions, roles, and privileges.

Case Study : Implementation of Unit I case study using SQL and PL/SQL

Unit III -Relational DBMS and Intelligent Querry Processing   (09 Hours)

Relational model concepts: Attributes, Domains, CODD's Rules. Integrity constraints: Domain, Referential integrity, Enterprise constraints.

Normalization: 1NF to BCNF, functional dependencies, decomposition. **Introduction to Intelligent Query Processing (IQP):** Definition and importance of IQP, Evolution of query processing techniques, Need for intelligent query optimization in modern databases.

Case study: Normalize the relational database designed in Unit I

Unit IV - Transaction Management & Analytics   (09 Hours)

Transactions: States, ACID properties, schedules. Serializability: Conflict and view serializability, cascaded aborts, recoverable and nonrecoverable schedules.

Concurrency control: Lock-based and time-stamp-based mechanisms, deadlock handling. Recovery: Shadow-paging, log-based recovery, checkpoints, deferred and immediate modifications.

Case study : Study transaction management in PostgreSQL

Unit V - NoSQL & Intelligent Data Processing   (09 Hours)

Data types: Structured, unstructured, and semi-structured data. NoSQL databases: Types (Key-value, Document, Graph, Wide-column), BASE properties, ACID vs. BASE, RDBMS vs. NoSQL

Introduction to emerging database technologies : Cloud Databases, Mobile Databases, SQLite Database, XML Databases, DynamoDB. MongoDB: CRUD operations, indexing, aggregation, MapReduce, replication, sharding.

Graph DB: Introduction, Building Rich Graph Data Models with Neo4j, Querying Your Graph Cosmos DB: Introduction, Building Scalable NoSQL Data Models, Querying with SQL API

Case study: Process unstructured social media data using NoSQL databases

Learning Resources

Text Books:

1. Silberschatz A., Korth H., Sudarshan S., "Database System Concepts", McGraw Hill Publishers, ISBN 0-07-120413-X, 6th edition

2. Connally T., Begg C., "Database Systems", 4th Edition, Pearson Education, 2002, ISBN 8178088614

3. "MongoDB: The Definitive Guide" by Kristina Chodorow, O Reilly Publications

4. Pramod J. Sadalage Martin Fowler," NoSQLDistilled",Addison Wesley, ISBN- 10:0321826620

Reference Books:

1. C J Date, "An Introduction to Database Systems", Addison-Wesley, ISBN: 0201144719

2. S.K.Singh, "Database Systems: Concepts, Design and Application", Pearson Education, ISBN 978-81-317-6092-5

3. Kristina Chodorow, Michael Dierolf, "MongoDB: The Definitive Guide", O Reilly Publications, ISBN: 978-1-449-34468-9

4. Adam Fowler, "NoSQL For Dummies", John Wiley & Sons, ISBN-1118905628

5. Kevin Roebuck, "Storing and Managing Big Data - NoSQL, HADOOP and More", Emereopty Limited, ISBN: 1743045743, 9781743045749

6. Joy A. Kreibich, "Using SQLite", O'REILLY, ISBN: 13:978-93-5110-934-1

7. Ivan Bayross, "SQL, PL/SQL the Programming Language of Oracle", BPB Publications ISBN: 9788176569644, 9788176569644

MOOC / NPTEL/YouTube Links: -

1. https://www.mongodb.com/resources/basics/databases/nosql-explained

2. https://learn.microsoft.com/en-us/azure/cosmos-db/nosql/modeling-data

3. https://onlinecourses.nptel.ac.in/noc22_cs91/preview

4. http://www.nptelvideos.com/lecture.php?id=6518

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science - 2024 Pattern		
PCC-252- AID : Data Science		
Teaching Scheme	Credits	Examination Scheme
Theory : 02 Hours/Week	02	CCE : 30 Marks End-Semester: 70 Marks

Prerequisite Courses, if any :

1. Programming and Problem Solving

2. Artificial Intelligence

Course Objectives: The course aims to:

1. Fundamental ideas, background, and real-world uses of data science.

2. Data analysis and foundations in statistics, probability, and linear algebra required for data science.

3. Fundamental machine learning concepts, algorithms, and assessment methods to address practical issues.

4. Data translation, cleansing, exploratory analysis, and visualization for decision-making.

5. Recent AutoML tools to perform different data science task.

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

- CO1: **Discuss** core concept of data science and its practical applications.

- CO2: **Apply** mathematical tools like linear algebra, probability, and statistics to model data-driven problem solutions.

- CO3: **Analyze** core machine learning algorithms and methodologies to address diverse problem sets.

- CO4: **Recommend** effective data cleaning, transformation, and visualization techniques to extract meaningful insights from data.

- CO5: **Use** automation tools for AI workflows to enhance the scalability and efficiency of AI-driven solutions.

Course Contents

Unit I -Fundamentals of Data Science (06 Hours)

Basic Concepts of Data: Types of data: Structured, Semi-structured, Unstructured, Scales of measurement: Nominal, Ordinal, Interval, Ratio, Data formats: CSV, JSON, XML, SQL tables, Data quality dimensions: Accuracy, Completeness, Consistency, Timeliness, Difference Between Data, Information, Knowledge, wisdom.

Definition of Data Science, The Data Science Process/Lifecycle (e.g., CRISP-DM, Team Data Science Process (TDSP), SEMMA Methodology), Applications of Data Science in various domains (e.g., Healthcare, Finance, Retail), Distinction between Data Science, Machine Learning, and Artificial Intelligence, Roles in Data Science (e.g., Data Analyst, Data Scientist, Machine Learning Engineer), Ethical and Privacy Issues in Data Science.

Case Study: A telecom business wants to proactively identify customers who are likely to quit because of the high rate of customer turnover. The organization wants to predict loss of customers using data science techniques and take proactive steps to keep at-risk clients.

Determine the steps that, as data scientists, we must adhere to in order to resolve this issue.

Unit II - Applications of Mathematical Statistics (06 Hours)

Importance of mathematical statistics in Data Science, Role of mathematical statistics in building data models, mathematical statistics foundations needed for machine learning algorithms.

Linear Algebra for Data Science: Vectors and Matrices, Vector operations (dot product, cross product) and its application in data science, Matrix operations (addition, multiplication, inverse, determinant), Eigenvalues and Eigenvectors and its uses in dimensionality reduction, Probability Concepts: Random variables and probability distributions, Bayes' Theorem and conditional probability, Expected value and variance.

Statistical Methods: Measures of central tendency (Mean, Median, Mode), Measures of dispersion (Variance, Standard Deviation) and its importance in data preprocessing ,Correlation and covariance and its importance in feature selection in modeling.

Case Study : In a dataset, you have a feature matrix and output vector .Elaborate, How does matrix multiplication help in solving linear regression using the Normal Equation.

Unit III - Programming for Data Science   (06 Hours)

Machine Learning: Types (Supervised, unsupervised, Reinforcement), Supervised Algorithms (Linear Regression, Logistic Regression, Decision Trees, SVM).

Metrics: Confusion Matrix, Accuracy, Precision-Recall, ROC-AUC, F1 Score, Mean Squared Error (MSE),R-squared.

NumPy: Arrays, Mathematical Operations, Linear Algebra, Random Number Generation, Broadcasting. Pandas: Data Frames, Cleaning, Transformation, Filtering, Grouping, Import/Export, Missing Data Handling.

Matplotlib: Basic & Advanced Plots, Customization, Subplots, Interactive Features. Seaborn: Distribution, Categorical, Relationship, Regression Plots, Multi-Plot Grids, Themes.

Case study: Write a case study on E-commerce Data. Key Components of the Analytical Plan are: Problem statement and objectives, Data Collection and Preparation, Data Analysis and Model Development, Analysis Outcomes and Takeaways

Unit IV - Data Preprocessing and Visualization   (06 Hours)

Data Preprocessing, Data Cleaning: Handling missing data, outliers. - Data Transformation Techniques: Feature Extraction and Selection (PCA), encoding. - Exploratory Data Analysis (EDA): Univariate, bivariate, multivariate analysis. Outliers: (Z-Score Method, Interquartile Range)

Data Visualization: Overview of Data Visualization, Need of Data Visualization, Shapes of data, input for data visualization, Types of Data Visualization: Cognitive and perceptual, Practicing good ethics in Data Visualization, Principles of visual perception, Data Visualization Tool (Tableau, Power BI)

Case study : 1. Case Study on Exploratory Data Analysis (EDA) and Visualizations 2. Create simple plot to visualize a distribution of variables using python

Unit V - Automating AI Workflows with Pandas   (06 Hours)

ETL, ETL Challenges, ETL in Data Preprocessing for AutoML, AutoML: AutoML Workflow, AutoML Libraries: Auto-sklearn, H2O.ai, and TPOT, Benefits and Limitations of AutoML, AutoML vs Traditional Machine Learning, Pandas for data preprocessing for AutoML, data normalization and standardization for AutoML,

Open-source Tools and Environments: Python, R, Jupyter, Git, VS Code and its roles in data science.
Introduction to Big Data: Characteristics, Architecture and Ecosystem, Tools and Technologies, Applications and Challenges of Big Data in Data Science.
AI-powered Data Cleaning: Using AI models to clean and structure raw data before analysis.

Case study: A retail company wants to predict its future sales revenue based on various factors such as product pricing, marketing spends, seasonal trends, and customer demographics. The company aims to use regression and classification models to analyze historical sales data, identify trends, and make data-driven decisions to enhance profitability and optimize resource allocation. Justify how does the choice between regression and classification models affect sales predictions?

Learning Resources

Text Books:

1. Vijay Kotu, Bala Deshpande, "Data Science Concepts and Practice", 2nd Edition, Morgan Kaufmann, ISBN 978-0-12-814761-0.

2. Suresh Kumar Mukhiya, Usman Ahmed, "Hands-On Exploratory Data Analysis with Python" 1st Edition, 2020, Packt Publish, ISBN 978-1-80323-110-5.

3. Dirk P. Kroese et.al.,"Data Science and Machine Learning: Mathematical and Statistical Methods",1st Edition, CRC Press, ISBN 978-1-138-49253-0.

Reference Books:

1. Davy Cielen, Arno D.B. Meysman, Mohamed Ali, "Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools", 1st Edition, Dreamtech Press, ISBN 978-1-63343-003-7.

2. Arockia Liborious, Rik Das, "Fun with Machine Learning", 1st Edition, BPB Publications, ISBN 978-93-555-1785-2

MOOC / NPTEL/YouTube Links: -

1. https://onlinecourses.nptel.ac.in/noc22_cs32/preview

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science - 2024 Pattern		
PCC-253- AID: Probability and Statistics		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 30 Marks **End-Semester:** 70 Marks

Prerequisite Courses, if any :

1. Set theory fundamentals

Course Objectives: The course aims to:

1. Demonstrate knowledge of probability and the standard statistical distributions

2. To impart probability concepts and Statistical methods in various applications in Engineering.

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

- CO1: Utilize key probability theorems to solve practical problems in decision-making and risk analysis.

- CO2: Apply fundamentals of Statistics for Artificial Intelligence and Data Science

- CO3: Apply statistical techniques to examine relationships between variables and make predictions.

- CO4: Use the basic principles of random variables and random processes needed in applications to model and interpret real-world scenarios.

- CO5: Use probability and statistical models to analyze data and support decision-making in fields like finance, engineering, healthcare, and machine learning.

Course Contents

Unit I -Introduction to Probability and Set Theory (09 Hours)

Basics of set Theory: Introduction to sets and algebra of sets, Random Experiment, Sample Space, Events, Complementary Events, Union and Intersection of Two Events, Difference Events, Exhaustive Events, Mutually Exclusive Events, Equally Likely Events, Independent Events.

Probability Theory: Mathematical & Statistical definition of Probability, Need of probability theory in Data science, Axiomatic definition of probability, Addition Theorem, Multiplication Theorem, Theorems of Probability, Conditional Probability, Inverse Probability, Joint Probability, Total Probability and Bayes Theorem.

Case Study: Use of probability in real-life situations, like weather forecasting, sports betting, sales forecasting etc

Unit II - Introduction to Statistics (09 Hours)

Introduction to Statistics: Introduction, Origin and Development and scope of Statistics, Population and Sample, Sampling –Introduction, Types of Sampling, Purposive Sampling, Random Sampling, Simple Sampling, Stratified Sampling, Parameter and Statistic, Sampling Distribution

Sampling With and Without Replacement, Population Parameters, Sample Statistics.

Introduction, Arithmetic Mean, Simple and weighted mean for raw data, Discrete frequency distribution, Continuous frequency distribution, Properties of A.M.,Merits & Demerits of A.M. Median, Mode for raw data, Merits and demerits of Median and Mode.

Case Study : Create measures of central tendency for a real-life example dataset, such as the payroll dataset or titanic dataset. Case study of sampling for any real-world problem like exit poll statistics

Unit III -Descriptive Statistics   (09 Hours)

Measures of Dispersion, Skewness and Kurtosis: Dispersion, Characteristics for an Ideal Measure of Dispersion, Measures of Dispersion, Range, Quartile Deviation, Mean Deviation, Standard Deviation and Root Mean Square Deviation, Coefficient of Dispersion, Coefficient of Variation, Skewness, Kurtosis.

Correlation and Regression : Bivariate Distribution, Scatter diagrams, Correlation, Karl Pearson's coefficient of correlation, Rank correlation, Regression, Regression Coefficients, Lines of Regression.

Case study: Create measures of dispersion for a real-life example dataset like students dataset, iris detection etc.

Unit IV - Random Variables and Probability Distributions   (09 Hours)

Random Variables and Distribution Functions: Random Variable, Distribution Function, Properties of Distribution Function, Discrete Random Variable, Probability Mass Function, Discrete Distribution Function, Continuous Random Variable, Probability Density Function, moment generating function, median and quantiles, Markov inequality, Chebyshev's inequality.

Theoretical Discrete Distributions: Binomial and multinomial distributions, Bernoulli Distribution, Mean Deviation about Mean of Binomial Distribution, Mode of Binomial Distribution, Additive Property of Binomial Distribution, Characteristic Function of Binomial Distribution, Cumulants of Binomial Distribution, Poisson distribution, Uniform distribution, Exponential distribution, Gaussian distribution, Log-normal distribution, Chi-square distribution.

Case study : Use Binomial distribution for the problem of reducing errors by vendors who process credit-card applications for a large credit-card bank etc.

Unit V - Inferential Statistics   (09 Hours)

Hypothesis and Testing of Hypothesis: Introduction, Statistical Hypothesis (Simple and-Composite), Test of a Statistical Hypothesis, Null Hypothesis, Alternative Hypothesis, Critical Region, Two Types of Errors, level of Significance, Power of the Test.

Steps in Solving Testing of Hypothesis Problem, Optimum Tests Under Different Situations, Most Powerful Test (MP Test), Uniformly Most Powerful Test, Likelihood Ratio Test, Properties of Likelihood Ratio Test. Neyman-Pearson Fundamental Lemma, Test for the Mean of a Normal Population, Test for the Equality of Means of Two Normal Populations, Test for the Variance of a Normal Population, Test for Equality of Variances of two Normal Populations, Non-parametric Methods, Advantages and Disadvantages of Non-parametric Methods.

Case study: Study hypothesis testing for any examples like to determine whether the female proportion of the adult population is high or any similar example

Learning Resources

Text Books:

1. S. C. Gupta, V. K. Kapoor, "Fundamentals of Mathematical Statistics (A Modern Approach)", Sultan Chand & Sons Educational Publishers, Tenth revised edition, ISBN: 81-7014-791-3

2. J. Medhi, "Statistical Methods: An Introductory Text", Second Edition, New Age International Ltd, ISBN: 8122419577

Reference Books:

1. Glen Cowan, " Statistical Data Analysis" , University Of Siegen, Clarendon Press, Oxford, 1998, ISBN: 0198501552

2. Probability, random variables and stochastic processes by A. Papoulis and S.U. Pillai, TMH

3. Ken Black, "Applied Business Statistics", Wiley, 7th Edition, ISBN:788126537075

4. Probability, Statistics and Random Process by T Veerarajan, TMH.

5. Introduction to Probability Theory and Statistical Inference by H.J. Larson.

E books Links: -

1. https://www.itl.nist.gov/div898/handbook/

2. https://web.stanford.edu/~hastie/ElemStatLearn/index.html

MOOC/SWAYAM/NPTEL Courses:

1. https://onlinecourses.nptel.ac.in/noc21_ma74/preview

2. https://archive.nptel.ac.in/courses/111/105/111105041/

3. https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-ma74/

4. https://onlinecourses.nptel.ac.in/noc23_ma77/preview

5. https://onlinecourses.nptel.ac.in/noc20_ma22/preview

6. https://nptel.ac.in/courses/110/106/110106072/

YouTube Videos :

1. https://youtu.be/tMnlo-P3IzQ

2. https://youtu.be/uzkc-qNVoOk

3. https://youtu.be/r1sLCDA-kNY

4. https://youtu.be/r1sLCDA-kNY?si=LxbfWcHtRSvhMKtA

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science - 2024 Pattern		
PCC-254 - AID: Database Management Systems Laboratory		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	01	**Term Work** : 25 Marks **Practical :** 25 Marks

Companion Course : Database Management Systems

Course Objectives: The course aims to:

1. To introduce the fundamental concepts of Database Management Systems.

2. To learn Database query languages and transaction processing.

3. To teach Systematic database design approaches.

4. Use of scalable, flexible databases for Big Data.

5. Advances in database technologies and applications.

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

- CO1: **Design** Database Management Systems using ER models.

- CO2: **Execute** database queries using SQL and PL/SQL.

- CO3: **Normalize** database designs using normal forms.

- CO4: **Apply** transaction management concepts to real-time scenarios.

- CO5: **Use** NoSQL databases for handling unstructured data.

Course Contents

Guidelines for Instructor's Manual

The instructor's manual/Lab 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), curriculum of course, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/guidelines, references.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable)), conclusion. 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. Students programs maintained on cloud or college server by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory for accreditation purpose.

Guidelines for Laboratory/Term Work Assessment

Continuous assessment of laboratory work should be done based on overall performance and Laboratory assignments performance of student. Each Laboratory assignment assessment should be assigned grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each Laboratory 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 needs 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 and distribute them among batches of students.

It is appreciated if the assignments are based on real world problems/applications. Use of open source software is to be encouraged. In addition to these, instructors may assign one real life application in the form of a mini-project based on the concepts learned. Instructors may also set one assignment or mini-project that is suitable to respective branch beyond the scope of the syllabus.

Guidelines for Practical Examination

Both internal and external examiners should jointly set problem statements. 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 test the student's for advanced learning, understanding of the fundamentals, effective and efficient implementation. So encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising start of the student's academics.

Suggested List of Laboratory Experiments/Assignments

1	**Introduction to Database Creation**

	Objective: Set up and create a database using MySQL/PostgreSQL.
	Task:
	Entities and Relationships:
	• Student (StudentID, Name, Email, Age, Address)
	• Course (CourseID, CourseName, Credits, InstructorID)
	• Instructor (InstructorID, Name, Email, Department)
	• Enrollment (EnrollmentID, StudentID, CourseID, EnrollmentDate)
	Relationships:
	• A student can enroll in multiple courses.
	• A course can have multiple students.
	• An instructor teaches one or more courses.
2	**Views and Indexing**
	Optimizing a Student Course Management System with Views and Indexing for Faster Query Performance.
	Objective: Understand views and indexing for performance optimization.
	Task:
	• Create views for easy reporting on students and course details.
	• Update and delete records using views where applicable.
	• Use indexing to speed up searches and measure query performance improvements.
3	**SQL Queries with Filters and Sorting**
	Advanced Querying in a Student Course Management System Using Filters, Sorting, and Nested Subqueries
	Objective: Use SQL filters and sorting clauses.
	Task:
	• Filtering Data with WHERE (Find students above a certain age, filter by instructor)
	• Sorting with ORDER BY (Alphabetically, by credits)
	• Aggregation with GROUP BY (Student count per course, average age)
	• Nested Subqueries for Complex Queries
4	**Multi-Table Joins**
	Develop a Customer Order Management System to Retrieve Data Using SQL Joins
	Objective: Learn inner and outer joins in SQL.
	Task:
	• INNER JOIN: Retrieve all customer orders (only customers who have placed orders).
	• LEFT JOIN: Retrieve all customers, including those who haven't placed any orders.
	• RIGHT JOIN: Retrieve all orders, including those placed by customers not in the Customers table.
	• FULL OUTER JOIN: Retrieve a complete list of customers and orders, including those that do not have a match in the other table.

5	**PL/SQL Procedures and Functions** Design and Implement a Sales Management System with Stored Procedures and Functions for Efficient Data Handling Objective: Implement stored procedures and functions. Task: • Create a stored procedure to add data to a table. • Create a function to calculate and return total sales.
6	**Triggers and Cursors** Develop an Employee Management System with Triggers for Audit Logging and Cursors for Efficient Data Processing Objective: Implement triggers and cursors in PL/SQL. Task: • Create a trigger on the Employees table that logs changes (INSERT, UPDATE, DELETE) into the Employee_Audit table. • Use a cursor to iterate through the Employees table and process salary increments based on certain conditions (e.g., increase salary by 10% for employees in the IT department).
7	**NoSQL Database Introduction – MongoDB Aggregation and Indexing** Objectives: Work with MongoDB for NoSQL data storage. Use MongoDB aggregation and indexing for data analysis. Task: • Create a MongoDB collection for user data. • Perform CRUD (Create, Read, Update, Delete) operations on the collection. • Write aggregation queries to calculate statistics (e.g., total sales, average age). • Create indexes and observe performance improvements.
8	**Case Study – Social Media Data Processing using NoSQL** Objective: Process unstructured social media data using NoSQL databases. Task: • Import a dataset with social media posts into MongoDB. • Write queries to filter and analyze data (e.g., find top trending hashtags).
9	**MySQL Database Backup and Recovery** Objective: To understand and practice the process of taking a backup of a MySQL database to ensure data security and disaster recovery.
10	**Compulsory Mini Project (Group of 2 to 3 students can develop mini project)** These projects align well with the syllabus, incorporating concepts like relational database design, SQL queries, PL/SQL, transaction management, and NoSQL. They also offer practical applications that can be demonstrated easily. Database connectivity with frontend and backend is compulsory.

	1. Library Management System Objective: Design a relational database to manage books, users, loans, and overdue notifications. Features: • Book search with filters • User login and role-based access • Loan and return history management
	2. Online Retail Store Database Objective: Develop a database for an e-commerce store to manage products, customers, orders, and inventory. Features: • Order placement and status tracking • Real-time inventory updates • Customer order history
	3. Student Attendance and Grade Management System Objective: Create a database for managing student attendance and grades for courses. Features: • Attendance recording and reporting • Grade calculation and storage • Performance analysis for students
	4. Hospital Patient Management System Objective: Design a database for managing patients, doctors, and appointments. Features: • Patient registration and medical history tracking • Doctor schedules and appointment booking • Billing and prescription management
	5. Movie Ticket Booking System Objective: Create a database for booking movie tickets with seat selection. Features: • Show listings and seat availability • Ticket booking and cancellation • Customer feedback collection
	6. Food Delivery System Objective: Design a database for managing restaurants, orders, and deliveries. Features: • Restaurant menu and order placement • Customer and delivery person management • Order tracking and delivery status
	7. Real Estate Property Management System Objective: Develop a system to manage properties, agents, and customers. Features: • Property listing with filters • Customer inquiries and appointments • Agent performance tracking

	8. Social Media Data Analysis using MongoDB Objective: Use a NoSQL database to analyze social media data such as user posts and hashtags. Features: • Hashtag trend identification • Sentiment analysis on user comments • Data aggregation for user engagement
	9. Online Voting System Objective: Create a secure database for managing elections and votes. Features: • Voter registration and verification • Voting and vote tallying • Result announcement and audit trail
	10. Event Management System Objective: Develop a database to manage events, participants, and schedules. Features: • Event registration and attendee tracking • Event schedules and notifications • Feedback collection and reporting

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science - 2024 Pattern

PCC-255-AID: Data Science Laboratory		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	01	**Oral :** 25 Marks

Companion Course : Data Science (PCC-205-AID)

Course Objectives: The course aims to:

1. Mathematical concepts of linear algebra, probability and statistics into coding environment.

2. Different visualization techniques and tools.

3. Effect of data preprocessing on the performance of machine learning algorithms.

4. Implementation of the different machine learning models.

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

- CO1: Implement Linear Algebra concepts using python.

- CO2: Apply data manipulation and preprocessing techniques on datasets.

- CO3: Use data visualization techniques and tools on the dataset.

- CO4: Develop machine learning model for application.

- CO5: Analyze performance of an algorithm.

Course Contents

Guidelines for Instructor's Manual

The instructor's manual/Lab 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), curriculum of course, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/guidelines, references.

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The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments 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. Students programs maintained on cloud or college server by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory for accreditation purpose.

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Guidelines for Laboratory Conduction

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It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of Hungarian notation, proper indentation and comments. Use of open source software is to be encouraged. In addition to these, instructors may assign one real life application in the form of a mini-project based on the concepts learned. Instructors may also set one assignment or mini-project that is suitable to respective branch beyond the scope of the syllabus.

Operating System recommended :- 64-bit Open source Linux or its derivative Programming tools recommended: - Python, tableau, Power BI etc.

Guidelines for Practical Examination

Both internal and external examiners should jointly set problem statements. 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 test the student's for advanced learning, understanding of the fundamentals, effective and efficient implementation. So encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising start of the student's academics.

Learning Resources

Virtual Laboratory:

1. http://cse01-iiith.vlabs.ac.in/

2. https://python-iitk.vlabs.ac.in/

3. https://python-iiith.vlabs.ac.in/

Suggested List of Laboratory Experiments/Assignments.

Assignments from both the Groups (A, B) are compulsory.

Sr.	Group A: Assignment on Python (Any SIX)
1	**Linear Algebra** a) Create a 3x3 square matrix and compute its determinant. b) Find the inverse of the matrix. c) Solve the following system of linear equations using NumPy: 2x+3y=10, 4x+5y=20

2	**Probability and Statistics using Python**: (Libraries Required: numpy, scipy.stats, matplotlib) 1. Generate a normal distribution and plot its histogram. 2. Compute mean, median, variance, and standard deviation for a dataset. 4. Simulate a coin toss experiment and compute probabilities.
3	Data is the backbone of analytical decision-making, and open-source datasets provide valuable insights into various real-world domains. In this task, identify a publicly available dataset from sources such as Kaggle or the UCI Machine Learning Repository. Describe the dataset in detail, including its purpose, key features, and source URL. Apply data manipulation techniques, including filtering specific rows based on conditions, grouping data by categorical variables, and computing aggregate statistics such as sum, mean, count, minimum, and maximum.
4	The Titanic disaster of 1912 resulted in the loss of many lives, and analyzing the survival patterns of passengers can provide valuable insights into factors that influenced survival rates. Using the Titanic dataset from Kaggle, perform data preprocessing, handle missing values, and create meaningful visualizations to explore relationships between variables such as passenger class, age, gender, and survival rate. The goal is to clean and analyze the dataset using Python, leveraging Pandas for data handling and Matplotlib/Seaborn for visualizations. By customizing charts with labels, colors, and titles, gain insights into passenger demographics, ticket class distributions, and survival trends. Uncover patterns in survival rates and contribute to a better understanding of historical data-driven decision-making. Dataset: https://www.kaggle.com/datasets/yasserh/titanic-dataset
5	Implement a linear regression model to predict house prices based on features such as size, number of rooms, and location. Use a dataset like the Boston Housing dataset from Kaggle Dataset: https://www.kaggle.com/datasets/altavish/boston-housing-dataset
6	Implement a logistic regression model to classify whether an email is spam or not. Use a dataset like the SpamBase dataset. Dataset: https://www.kaggle.com/datasets/colormap/spambase
7	A streaming platform wants to recommend movies to users based on their past ratings. Develop a model that predicts user ratings and classify them into high or low ratings. Dataset: MovieLens Dataset (GroupLens)
8	Predict the price of the Uber ride from a given pickup point to the agreed drop-off location. Perform following tasks: 1. Pre-process the dataset. 2. Identify outliers.3. Check the correlation. 4. Implement linear regression and random forest regression models. Evaluate the models and compare their respective scores like R2, RMSE, etc. Dataset link: https://www.kaggle.com/datasets/yasserh/uber-fares-dataset
	Group B: Assignment on Data Science Tools (Any TWO)

1	**Sales Performance Reporting Using Power BI** Create an interactive Power BI report to analyze and visualize the sales performance of a fictional retail company. Dataset: https://www.kaggle.com/datasets/mohammadtalib786/retail-sales-dataset Report Requirements: **Build a Sales Dashboard showing:** • Total Sales • Total Units Sold • Top 5 Products by Sales • Sales by Region (Map Visualization) • Monthly Sales Trend (Line Chart) **Add filters for:** • Product Category • Region • Time Period **Technical Requirements:** • Use at least three different types of visuals (e.g., bar chart, line chart, map). • Create at least one calculated column and one measure using DAX. • Implement basic data cleaning using Power Query.
2	**HR Analytics Reporting Using Power BI** Design a Power BI report to help the HR department monitor employee metrics and retention Dataset: https://www.kaggle.com/datasets/pavansubhasht/ibm-hr-analytics-attrition-dataset **Report Requirements:** • Build an HR Dashboard displaying • Headcount by Department • Gender Diversity (Pie Chart) • Average Tenure by Department (Bar Chart) • Attrition Rate (KPI Card) • Age Distribution (Histogram) **Technical Requirements:** • Create a calculated measure for Attrition Rate (Number of employees who left ÷ Total employees). • Develop a Date Table and create a relationship with the "Date of Joining" column for time-based analysis.
3	**Exploring Global COVID-19 Trends Using Tableau** Dataset: https://www.kaggle.com/datasets/josephassaker/covid19-global-dataset Identify • trends in cases • deaths, • vaccinations across countries and continents. Create an interactive dashboard using fundamental Tableau skills such as chart creation, filtering, mapping, and layout design.
4	A college wants to improve academic outcomes for its undergraduate students. The Academic Affairs Department has hired a team of junior data science interns to investigate factors that influence student performance and suggest data-driven interventions. Identify key factors affecting students' academic performance and recommend strategies to improve results. Perform Data collection, simulate surveys, data cleaning, EDA, feature engineering and modelling. Evaluate the performance of algorithm. Write an executive summary with key findings, Visualizations (charts, plots) showing analysis, and recommendations. [Instructor can create other scenarios as well for this assignment, this can be performed in group]

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science - 2024 Pattern		
MDM-271-AID - Embedded Systems		
Teaching Scheme	Credits	Examination Scheme
Theory : 02 Hours/Week	02	**CCE** : 30 Marks **End-Semester:** 70 Marks

Prerequisite Courses, if any :

1. Digital Electronics and Logic Design, Operating Systems

Course Objectives: The course aims to:

1. To Define key concepts and components of embedded systems, such as microcontrollers, sensors, and actuators

2. To understand ARM Processor

3. To recall key concepts, terms, and definitions related to real-time operating systems.

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

- CO1: Apply knowledge of embedded systems, its characteristics, classifications, and real-world applications across various domains.

- CO2: Make use of micro controllers and develop programming and interfacing skills using Arduino and Raspberry Pi.

- CO3: Explain the working mechanisms of different sensors and actuators and their relevance in various applications.

- CO4: Identify the fundamental architecture of ARM Processor.

- CO5: Compare the working of real-time scheduling algorithms

Course Contents

Unit I - Introduction to Embedded Systems (06 Hours)

Introduction to embedded system,application domain,Desirable Features and General Characteristics of Embedded Systems,Example of a Simple Embedded System,Figures of Merit for an Embedded System,Classification of MCUs: 4/8/16/32 Bits,History of Embedded Systems, classification of embedded system ,Current Trends,example of embedded system:-Mobile Phone,Automotive Electronics,Radio Frequency Identification (RFID),Robotics

Case Study: Smart Traffic Light Control System Using Embedded Systems

Unit II - Microcontrollers in Embedded System (06 Hours)

History of Microcontrollers, Introduction to Arduino, Components of Arduino, History of Arduino, Installing Software, Structure of Programming, Overview of Variables, Infinite Loops, Compiling, Linking and Debugging.

Raspberry Pi, About the Board, Linux on Raspberry Pi, Raspberry Pi Interfaces, Programming Raspberry Pi with Python.

Controlling LED with Raspberry Pi, Interfacing an LED and Switch with Raspberry Pi, Interfacing a Light Sensor (LDR) with Raspberry Pi.

Case Study : Home Automation System Using Arduino

Unit III - Sensors , ADCs and Actuators   (06 Hours)

Basics of Sensors and Actuators, Active vs. passive sensors, Analog vs. digital sensors, Types of Sensors :Temperature Sensors,Light Sensors,Photojunction Devices,Proximity/Range Sensors,Humidity Sensors,pressure sensor,ultrasonic sensor,gas sensors,Analog to Digital Converters. Digital to Analog Converters,Types of Actuators ,Displays-LEDs, Liquid Crystal Displays (LCDs) ,seven segment display, stepper motor, Relay.

Case study: Smart laboratory Monitoring System

Unit IV - ARM Processor   (06 Hours)

Introduction, RISC design philosophy, ARM design philosophy, Embedded system hardware – AMBA bus protocol, ARM bus technology, Memory, Peripherals, Embedded system software – Initialization (BOOT)code, Operating System, Applications.

ARM Processor Fundamentals, ARM core dataflow model, registers, current program status register,Pipeline, Exceptions, Interrupts and Vector Table, Core extensions.

Case study : Smart Agriculture Monitoring System

Unit V -Real time operating systems   (06 Hours)

Introduction,Real-time Tasks,Real-time Systems,Real-time Operating Systems, types of real time tasks,Real-time Scheduling Algorithms,Rate Monotonic Algorithm,The Earliest Deadline First Algorithm Task synchronisation, Device Drivers

Case study: Installation of Real Time Operating System

Learning Resources

Text Books:

1. Andrew N Sloss, Dominic System and Chris Wright, "ARM System Developers Guide", Elsevier, Morgan Kaufman publisher, 1st Edition, 2008

2. Lyla B Das "Embedded systems an integrated approach",Pearson

3. Raj Kamal. " Embedded systems" , Tata McGraw Hill,Fourth Edition

4. Simon Monk ,"Programming Ardino",McGraw Hill,Second edition

Reference Books:

1. A.Ray, K.Bhurchandi, "Advanced Microprocessors and peripherals: Arch, Programming & Interfacing", Tata McGraw Hill,2004 ISBN 0-07-463841-6

2. Shibu K. V. "Introduction to embedded system" Tata McGraw Hill,Second Edition

3. Parag H. Dave, " Embedded Systems- Concept,Design and Programming", Pearson

MOOC / NPTEL/YouTube Links: -

1. https://onlinecourses.nptel.ac.in/noc25_ee31

2. https://onlinecourses.nptel.ac.in/noc25_cs30

3. https://onlinecourses.nptel.ac.in/noc25_cs41/

4. https://www.coursera.org/specializations/real-time-embedded-systems

5. https://www.coursera.org/learn/iot

Online Links: -

1. https://link.springer.com/book/10.1007/978-3-030-60910-8
2. https://ptolemy.berkeley.edu/books/leeseshia/releases/LeeSeshia_DigitalV2_2.pdf
3. https://agsci.colostate.edu/wp-content/uploads/sites/95/2020/03/Programming-Arduino.pdf

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science - 2024 Pattern		
VSE-281-AID : Object Oriented Programming		
Teaching Scheme	Credits	Examination Scheme
Practical : 04 Hours/Week	02	**Term Work** : 25 Marks **Practical :** 25 Marks

Prerequisite Courses, if any :

1. Good understanding of Programming and Problem Solving concepts

Course Objectives: The course aims to:

1. The principles of object-oriented programming (OOP).

2. Object-oriented paradigm in program design.

3. Object-oriented programming insight using Java

4. Advanced Java Programming.

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.

- CO5: **Design** an interface to connect Java applications with database for performing CRUD operations.

- CO6: **Perform** basic statistical analysis and data visualization operations using Java AP

Course Contents

Introduction to OOP Concepts and Control Structure

Programming paradigms- Introduction to programming paradigms, Introduction to four main Programming paradigms- procedural, object oriented, functional, and logic & rule based. Need of object-oriented programming,

Fundamentals of object-oriented programming: Namespaces, objects, classes, data members, methods, messages, data encapsulation, data abstraction and information hiding, inheritance, polymorphism. Benefits of OOP, Java as object oriented programming language.

Overview of java Language: simple java program structure: documentation section, package statement, import statements, class definition, main method class. Implementing Java Program, JVM,

Data types, Primitive Types vs. Reference type, floating point numbers, operators and expressions, Java Class Libraries, Typical Java Development Environment, and Memory Concepts.

Control Statements: Selection Statements: if, if-else, nested if-else, Iteration Statements: do, while, for, for-each statement, break, and continue statements

Case Study:

Introduction to Classes and Objects and Arrays

Introduction to Classes and Objects: Defining a Class, Field declaration, method declaration and definition, instantiating an object of a Class, Accessing class members, declaring methods with multiple parameters, argument passing, object as a parameter, returning objects, assigning object reference variables, set methods and get methods, constructors, this keyword, Constructors, static methods, scope of declaration, method overloading and Java API packages.

Arrays: declaring and creating arrays in java, examples using arrays, passing arrays to methods, multidimensional arrays, variable-length argument lists, using command-line arguments.

Managing I/O: Streams, Byte Streams and Character Streams, Predefined Streams, Reading console Input, Writing Console Output, Print Writer class.

Inheritance and Polymorphism

Inheritance: Super classes and Subclasses, protected members, relationship between super classes and subclasses, types of Inheritance, constructors in subclasses, object class.

Polymorphism: Abstract classes and methods, final methods and classes, dynamic binding, polymorphism examples and Interfaces.

Exception Handling and Multithreading

Exception handling: fundamentals, Exception Types, Using try-catch, Multiple try-catch clauses, Nested try statements, throw, throws, finally, Built-in Exceptions

Multi Threading: Java Thread Model, Main Thread, Creating a Thread , Creating Multiple Threads, Using isAlive() and join(), Thread Priorities, synchronization, Suspending, Resuming, and Stopping Threads.

Advance Java Concepts

Database Connectivity: Basics of JDBC, Connecting Java with MySQL/PostgreSQL, CRUD Operations using JDBC, Introduction to Prepared Statements

Java in Data Science: Overview, Reading and Writing Data (CSV, JSON), Basic Statistical Operations using Apache Commons Math, Introduction to JavaFX for Data Visualization

List of Assignment (Part A) - Any 4

Sr.	Objective
1	Implement a robust Java calculator program that captures user input dynamically, processes mathematical expressions using conditional logic and looping constructs, and ensures efficient error handling.

2	Develop a Java program for an E-commerce order processing where some products are initialized through multiple constructors, users can input some product details manually, the system computes total order cost dynamically, applies discount policies based on conditions, and presents a detailed invoice summarizing the purchase.
3	Write a Java program that demonstrates the overloading method to compute power and absolute of a number for various data types and utilizes the static method from Math class for the same operation
4	Write a Java program to implement a Library Management System where books can be added, issued, and returned. The system should track the total number of books using a static field and allow users to view book details, issue or return books, and check the total book count using static methods
5	Develop a Java program that performs various operations on arrays, including displaying elements, finding the maximum and minimum elements, calculating the sum and average of elements, and searching for a specific element within the array.
6	Develop a Java program that implements a simple hotel room booking system using two-dimensional arrays. The system allows users to: View available and booked rooms, Book a room by selecting a floor and room number and exit the system when finished

List of Assignment (Part B) - Any 4

Sr.	Objective
1	Create a Java program demonstrating single inheritance where a subclass extends a superclass and calls its methods.
2	Implement an interface in Java and create multiple classes that implement the interface, demonstrating polymorphism.
3	Write a Java program to create an abstract class with an abstract method and extend it in a subclass that provides an implementation.
4	Develop a Java application that simulates an ATM machine. Implement functionalities like checking account balance, withdrawing, and depositing money. Use try, catch, and finally blocks to handle potential exceptions such as insufficient funds (throwing ArithmeticException) and invalid input (throwing IllegalArgumentException). Ensure that the application continues to run smoothly after handling exceptions.
5	Develop a Java application that simulates an online shopping system. Implement functionalities such as adding items to the cart, calculating the total price, and processing payments. Use try, catch, and finally blocks to handle exceptions like NumberFormatException for invalid input and ArithmeticException for any calculation errors.

6	Develop a Java application that monitors stock prices in real-time using two threads. One thread should fetch the stock prices from an API, and the other should display the prices. Use Thread.sleep() to simulate the delay in fetching prices and join() to ensure both threads complete before displaying the results. Implement thread synchronization to handle simultaneous access to shared resources.
7	Create a multi-threaded Java application that simulates a basic chat system. Each user (thread) sends and receives messages. Use isAlive() to check the status of threads and join() to ensure proper synchronization. Implement thread priorities to handle high-priority messages and demonstrate thread suspension, resumption, and stopping.

List of Assignment (Part C - Any 2

Sr.	Objective
1	Create a Java application that connects to a MySQL/PostgreSQL database to manage employee information. Implement functionalities like adding, updating, deleting, and viewing employee records using JDBC. Use prepared statements to prevent SQL injection and handle exceptions gracefully.
2	Develop a Java application that connects to a MySQL/PostgreSQL database to manage student information. Implement CRUD operations for student records using JDBC. Use prepared statements to handle SQL queries securely and ensure proper transaction management.
3	Create a Java application that reads weather data from a CSV file and performs basic statistical operations using Apache Commons Math. Use JavaFX to create interactive charts and graphs to visualize temperature trends, humidity levels, and other weather parameters.
4	Develop a Java application that reads patient data from a CSV file and calculates basic statistics such as average age, median heart rate, and standard deviation of blood pressure using the Apache Commons Math library. Implement functionality to visualize the data using JavaFX charts

List of Assignment (Part D) Mini Project

Sr.	Objective
1	Banking system having the following operations: a. Create an account b. Deposit money c. Withdraw money d. Honor daily withdrawal limit e. Check the balance f. Display Account information.

2	Inventory managementsystem having the following operations: a. List of all products b. Display individual product information c. Purchase d. Shipping e. Balance stock f. Loss and Profit calculation.

Learning Resources

Text Books:

1. E Balaguruswamy, (2023). Programming with JAVA: A Primer. 7th edition. India: McGraw Hill Education

2. Herbert Schildt, (2021). Java: The complete reference, 13th edition. McGraw-Hill Education.

Reference Books:

1. Paul Deitel and Harvey Detail, Java: How to Program, Pearson's Publication, 9thEdition

2. Horstmann, C. S. (2023). Core Java - Vol. I – Fundamentals (Vol. 12). Pearson Education.

MOOC / NPTEL/YouTube Links: -

1. Programming In Java: https://onlinecourses.nptel.ac.in/noc25_cs57/preview

Savitribai Phule University			
Second Year of Artificial Intelligence and Data Science - 2024 Pattern			
AEC-282- COM: Modern Indian Language (Marathi)			
Teaching Scheme	Credits	Examination Scheme	
Tutorial : 01 Hour/Week **Practical** : 02 Hours/Week	01 01	**Term Work** : 50 Marks	

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

Case Study:

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

Text Books:

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.

Guidelines Term Work conduction and Evaluation

Implementation Guidelines

1. Subject teacher should frame minimum 08 assignments-based covering on all four units.

2. Scaffolding: Start with simpler tasks and gradually increase complexity. Provide necessary vocabulary and grammatical structures beforehand.

3. Differentiation: Offer varied levels of support for students with different proficiency.

4. Pair Work & Group Work: Encourage collaborative learning and peer correction.

5. Feedback: Provide constructive feedback on all assignments, focusing on both accuracy and fluency.

6. Authentic Materials: Use real-world Marathi materials (simple songs, short videos, advertisements) as much as possible.

7. Cultural Context: Integrate cultural aspects into the assignments (e.g., describing a Marathi festival, a famous personality).

8. Fun & Engaging: Make the activities enjoyable to keep students motivated. Use games and competitive elements where appropriate.

9. Technology Integration: Use online dictionaries, translation tools (with caution), and Marathi typing tools.

10. These assignments can be adapted based on the students' proficiency level and the specific learning objectives of the Marathi course.

Suggested List of Assignments

1. "Samvad Sadara Kara" (Present a Dialogue): Role-Playing Everyday Scenarios: Objective is to practice conversational Marathi, understanding social cues. In pairs or small groups, students create and perform a short dialogue based on a given scenario.

2. Vartamanpatra Vachan" (Newspaper Reading): (Columns like Sports, political, finance, editorial, education, international news etc) in the daily Marathi newspapers, summarize and present in the practical. A summary should be added as part of the journal.

3. Creative writing: Write blogs and posts on social media up to 200 words on recent development in their field of study

4. "Mala He Sangayche Aahe" (I Want to Say This): Students are expected to show the objects and describe it to the class in Marathi. They should mention its color, size, use, why it's important to them, etc.

5. Professional letter / report writing

   (a) Write a letter to the principal/director for organizing NSS camp in nearby village. Preparation of the budget, permission letters and report submission in the University

   (b) Write a letter for internship sponsorship to any organization.

6. Book Review – Students are expected to read any novel, fiction or literature book of their choice and write a review on post it on social media of their choice.

7. Participation in Competitions (in college/out side the college) debate, declamation, elocution – A Report should be submitted

8. Group Activity: Road show, skit play, one-act play

9. Participation in One-Act-Play - Participation in Purushottam karandam, Firodia karandak, Dajikaka Gadgil Karandak and Shreetej Karandak.

10. Marathi Film Review – Watch the Marathi movie widely available on an OTT (Over-The-Top) platform , broadcaster in Television or availle on YouTube and write a review.

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science - 2024 Pattern		
EEM-283-AID- Technology Commercialization and Startup Development		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week **Tutorial** : 01 Hour/Week	01 01	**Term Work :** 25 Marks

Course Objectives: The course aims to:

1. Importance of technology commercialization and startup.

2. Intellectual property rights for protecting invention with product ownership.

3. Requisite knowledge of Registration process of for startup.

4. Setup of cost & funding for startup.

5. Go-to-Market (GTM) strategy for business venture.

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

- CO1: **Apply** the concepts of the technology commercialization for starting a new venture.

- CO2: **Register** invention to protect the invention through IPR.

- CO3: **Discuss** the registration process with requisite market knowledge, skills and right attitude.

- CO4: **Create** the costing sheet by identifying the available funding resources.

- CO5: **Implement** Go-to-Market strategy for a business venture.

Course Contents

Unit I - Introduction to Technology commercialization & Startup ecosystem (03 Hours)

Introduction, Need and importance of commercialization, role of startup in technology and commercialization, challenges in technology commercialization, support systems for startups, future trends in technology.

Case Studies : Electric car, Pharma company, Joint venture, Agriculture

Unit II - IPR & Legal compliance (03 Hours)

Invention and innovation: need, benefits, intellectual property rights protection, patent drafting, procedure of IPR filing, legal policies, IT act, GST and income tax , companies act, labor law, environmental protection act.

Case Study : Google search algorithm, Pepsi ingredient

Unit III - Registration process & Market research (03 Hours)

Registration process: Steps to register startup with startup India, benefits of startup registration, requisites documents & information, startup eligibility criteria. Market research: Development of

marketing plan, pricing concepts and pricing strategy, consumer behavior, market intelligence, marketing communication and promotional strategies.

Case study: Proprietary firm- Patnajali Ayurveda, Private Limited Company-TCS, Partnership- Khaitan & Co.

Unit IV - Costing & Funding strategy (03 Hours)

One time cost: Need, financial components, business formation and registration, professional services , advertising, infrastructure, technology, recurring cost: rent, salaries, insurance, tax, loan, maintenance, travel and training, types of startup funding, stages of startups and source of funding, steps to startup fund raising, types of investors, investors look for in startups , investors mindset to invest in startups , startup India funding support, startup India investor connect, credit guarantee scheme for startups

Case study : Rapido, Blinkit, OYO, Unacademy

Unit V - Growth and scaling -Go to market strategy (03 Hours)

Growth and scaling: significance, difference, scaling key metrics, identifying target segments and personas, analyzing customer needs and competitive landscape, value propositions, unique selling points (USPs), choosing distribution channels, pricing strategies, marketing, positioning plans, ansoff matrix, scaling frameworks, organic vs. inorganic growth strategies, leveraging technology, partnerships for scalability, key Performance indicators for GTM, Feedback loops and agile adaptation.

Case study: Zomato's Expansion Strategy in Tier 2 and 3 Cities , Analyze how Zomato tailored its GTM strategy to penetrate smaller markets, adjusted pricing, and adapted to local preferences.

Practical Assignments

1. Choose the topic for technology commercialization for the prospect of startup.

2. Design a market research plan for identified area.

3. Create a funding proposal based on overall costing of startup

4. Creation of patent draft copy on invention.

5. Design a Go-to-Market strategy for a startup launching.

Learning Resources

Text Books:

1. Fundamentals of Information Technology Author: Shambhavi Roy, Clinton Daniel, and Manish Agrawal.

2. 8 Steps To Innovation: Going From Jugaad To Excellence, Collins India, 2013. ISBN: 9789350293584

3. National Student and Faculty Startup Policy 2019. Government of India.

4. Pavan Soni, "Design Your Thinking - The Mindsets, Toolsets and Skill Sets For Creative Problem Solving", Penguin Random House India Pvt. Ltd. 2020, ISBN: 9780670094097.

5. Intellectual Property, A primer for academia, Prof. Rupinder Tiwari, Mamta Bharadwaj, Publication Bureau Panjab University Chandigarh. https://dst.gov.in/sites/default/files/E-BOOK%20IPR.pdf.

6. Law Relating to Intellectual Property Rights by V.K. Ahuja

7. Sangeeta Sharma, Raghu Raman, Entrepreneurship Development – Prentice Hall India, 2021,ISBN: 9390544254

8. Donald F. Kuratko, Entrepreneurship: Theory, Process, Practice with MindTap,- Cengage Learning India Pvt. Ltd. 2022, ISBN: 9789355734006

Reference Books:

1. Information Technology Author: V.Rajaraman

2. Innovation and Entrepreneurship, Peter F. Drucker, Harper Business; Reprint, 2006, ISBN: 9780060851132.

3. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Crown Currency; Illustrated, 2011. ISBN: 9780307887894.

4. Innovator's DNA, Updated, with a New Preface: Mastering the Five Skills of Disruptive Innovators, Harvard Business Review Press; Revised, 2019. ISBN: 1633697207.

5. Wiley Innovation Black Book Enterprise 4.0, 2020.

6. Problem-Solving", Penguin Random House India Pvt. Ltd. 2020, ISBN: 9780670094097

7. HBS series on Innovation and Entrepreneurship

8. https://www.startupindia.gov.in/content/dam/investindia/Templates/public/Startup%20India%20Ki

9. Fundamentals of Intellectual Property Rights by Anil Kumar H S and B. Ramakrishna.

10. Philip Kotler, Kevin Lane Keller, Marketing Management – Pearson Education, 16e, 2022,ISBN 9356062668

E-Books Links: -

1. Technology Laws Decoded Author N.S.Nappinai

2. IPR-eng-ebook by bharatidasan University

3. Fundamentals Of Intellectual Property Rights And Patents by Rashika Kapadiya.

4. Peter Thiel, Blake Masters ,Zero to One: Notes on Startups, or How to Build the Future Crown Publishing Group,2014, 978-0-8041-3930-4

5. https://dst.gov.in/sites/default/files/E-BOOK%20IPR.pdf

Links to online SWAYAM/NPTEL Courses:-

1. Innovation Business Model and Entrepreneurshipby Prof. Rajat Agrawal, Prof.Vinay Sharma I2IT Rookee.

2. Innovation and Start-up Policy By Prof. Rahul K. Mishra IILM Institute for Higher Education

3. https://onlinecourses.swayam2.ac.in/imb20_mg22/preview

4. Innovation, Business Models and Entrepreneurship, By Prof . Rajat Agrawal and Prof. Vinay Sharma | IIT Roorkee

5. https://onlinecourses.nptel.ac.in/noc19_mg55/preview

6. https://onlinecourses.nptel.ac.in/noc22_hs59/preview

7. Innovation Driven Entrepreneurship https://onlinecourses.swayam2.ac.in/ntr24_ed05/preview

YouTube/Video Links:

1. https://www.youtube.com/watch?v=7BfdMKeLTj0

2. https://www.youtube.com/watch?v=zkWJAvg6_ME

3. https://www.youtube.com/watch?v=rqi-n0hA4uo

4. https://www.youtube.com/watch?v=F4YuptMRMBY

5. https://www.youtube.com/watch?v=6lY9CYIY4pQ

6. https://www.youtube.com/watch?v=zwQ8TNkcYzc

7. https://www.youtube.com/watch?v=NP2pXTdyEGc

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science - 2024 Pattern

VEC-284- AID - Environmental Studies		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week	02	**CCE :** 15 Marks **End-Sem Examination :** 35 Marks

Course Objectives: The course aims to:

1. To introduce the multidisciplinary nature and scope of environmental studies.

2. To understand ecosystem structures, biodiversity, and ecological balance through hands-on observation and documentation.

3. To examine the use and impact of natural resources on environmental sustainability.

4. To explore biodiversity conservation practices and develop eco-sensitive thinking through field-based inquiry.

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

- CO1. **Illustrate** the interdependence of ecosystems through activity-based exploration

- CO2. **Analyze** the role of natural resources in sustainable development using real-world data.

- CO3. **Investigate** biodiversity threats and conservation strategies through surveys and projects

- CO4. **Create** awareness tools or **reports** promoting sustainability based on their findings.

Course Contents

Unit I - Environment and its issues (07 Hours)

a) Environment Meaning of Environment, Types of Environment, Components of Environment,
b) Man- Environment relationship, importance of environment,
c) Need for Public Awareness
d) Ecosystem-Meaning, Major Components of Ecosystem
e) Case studies of Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem, Aquatic Ecosystem
f) Stability of Ecosystem in Sustainable Environment

Unit III - Environment Pollution (07 Hours)

a) Definition of Pollution, Types of Pollution
b) Air Pollution-Meaning, Sources, effects of air pollution, Air Pollution Act
c) Water Pollution Meaning, Sources, Effects of Water pollution, Water Pollution Act
d) Noise Pollution Meaning, Sources, Effect of Noise Pollution
e) Solid Waste Pollution Meaning, sources, Effect of Waste Pollution

Unit III - E-Waste Managements and Acts (08 Hours)

E- waste; composition and generation. Global context in e- waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E- waste) on human health and surrounding environment,

domestic e-waste disposal, Basic principles of E waste management, Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials-mechanical processing, technologies for recovery of materials, occupational and environmental health perspectives of recycling e-waste in India.

Unit IV - E-waste Control and measures

Need for stringent health safeguards and environmental protection laws in India, Extended Producers Responsibility (EPR), Import of e-waste permissions, Producer-Public-Government cooperation, Administrative Controls & Engineering controls, monitoring of compliance of Rules, Effective regulatory mechanism strengthened by manpower and technical expertise, Reduction of waste at source

Practical Assignments

Week	Topic to be covered
1	Introduction : Group discussion and poster making on "Why Environmental Studies Matter for Technologists"
2	Eco Mapping: Identify and document elements of an ecosystem within the college campus
3	Model the Food Web: Create food chains and food webs using flowcharts (digital tools like Canva / Lucid chart)
4	Case Study Review: Present real-world examples of forest, grassland, and aquatic ecosystems
5	Soil and Water Testing Activity: Test soil pH, water quality (use school-level kits), and interpret results
6	Field Visit / Virtual Tour: Document deforestation or mining impact in a chosen region; students prepare a comparative report
7	Water Audit Exercise: Estimate water usage at home/hostel and identify areas of overuse; propose conservation measures
8	Renewable Energy Models: Create a simple model or PPT on any renewable energy source (e.g., solar cooker, wind energy demo)
9	Biodiversity Documentation: Survey nearby areas for plant/animal species; identify any endemic/endangered species
10	Conservation Proposal Pitch: In groups, students prepare a mini proposal for biodiversity conservation at local level
11	Group Project Work: Work on mini project report/documentation on any ecosystem/natural resource/e-waste management topics
12	Presentation & Viva: Final presentation and oral examination based on project work and learning portfolio

Learning Resources

Text Books:

1. Odum, Eugene P. "Fundamentals of Ecology"

2. R. Rajagopalan, "Environmental Studies – From Crisis to Cure", Oxford

3. Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi

Reference Books:

1. Erach Bharucha, "Textbook of Environmental Studies", UGC

2. Anubha Kaushik and C.P. Kaushik, "Environmental Studies", New Age International

E-Books Links: -

1. https://www.environment.gov.in

2. https://www.unep.org

3. https://news.mit.edu/2013/ewaste-mit

Savitribai Phule Pune University, Pune

Maharashtra, India

Task Force for Curriculum Design and Development

Programme Coordinator

Dr. Dipti D. Patil - Member, Board of Studies - Computer Engineering

Core Committee Members

Dr. Girish Potdar	Dr. Shraddha Pandit
Dr. Kalpana Metre	Dr. Chhaya Gosavi
Dr. Pravin Futane	Prof. Vinay Nalawade
Dr. Dikshendra Sarpate	

Team Members for Course Design

Data Structure	
Dr. Girish Potdar	Pune Institute of Computer Technology
Dr. Shwetal Patil	Marathwada Mitra Mandal's Institute of Technology
Dr Vijay More	MET's Institute of Engineering, Bhujbal Knowledge City, Nashik
Dr. Shalaka P Deore	MES Wadia college of engineering
Pallavi V Kulkarni	Government College of Engineering and Research Avasari
Dr. Savita Kumbhare	Dr. D. Y. Patil Institute of Technology Pimpri
Mr.Dipak Pawar	Collabera Digital

Probability and Statistics	
Dr. Chhaya Gosavi	Cummins COEW,Pune
Mrs.Geeta M Kodabagi	Ajeenkya DY Patil school of engineering Lohegaon pune
Prof.Jitendra Garud	DYPEMR
Ms.Shreeya Palkar	PESMCOE
Prof. Prasad B. Jare	S B Patil College of Engineering, Indapur
Dr.Javed Shaikh	Captal Numbers Infotech Pvt Ltd

Operating Systems

Dr. Chhaya Gosawi	MKSSS Cummins College of Engineering for Women
Dr. Bhagyashree Dhakulkar	Ajeenkya DY Patil school of engineering Lohegaon pune
Dr. Kirti Wanjale	Vishwakarma Institute of Technology
Ms. Disha Sengupta	Dr. D. Y. Patil Institute of Technology, Pimpri
Dr Jyoti Y Deshmukh	Marathwada Mitramandal's Institute of technology Pune
Prof.V N Naykwadi	Zeal college of engineering and research pune
Mr.Sagar Bhosale	Google (Software Engineer)

Database Management Systems

Prof. Vinay S. Nalawade	S B Patil College of Engineering,Indapur
Dr. Sachin A Thanekar	Amrutvahini College of Engineering, Sangamner
Dr Hemantkumar B Jadhav	Adsul's Technical Campus, Ahilyanagar
Mr. Kuldeep Hule	Army Institute of Technology Pune
Prof.Pradip N Shendage	Vidya Pratishthan's Kamalnayan Bajaj Institute of Engineering
Prof. Sayali A Belhe	AISSMS IOIT , Pune
Mr. Balaji R. Londhe	Northern Trust

Artificial Intelligence

Dr. Dikshendra Sarpate	Zeal COER,Pune
Dr Aarti Dandavate	Dhole patil college of engineering Pune
Dr Nisha Deepak Patil	MET's Institute of Engineering, Nashik
Prof.Surbhi Dilip Pagar	DYPIEMR,Akurdi
Prof. Megha Patil	Bharati Vidyapeeth's College of Engineering, Lavale, Pune.
Mr. Anshuman V Jadhav	Blue Flame Labs Ltd.

Data Science

Dr. Dikshendra Sarpate	Zeal COER,Pune
Dr. Rama Gaikwad	Anantrao Pawar college of Engineering and Research
Dr. Brijendra Gupta	Siddhant college of engineering, Pune
Prof.Renuka sumit vaidya	Sinhgad college of engineering pune
Prof.Neelam Jain	Ajeenkya dy patil school of Engineering Lohegaon
Mr. Anshuman V Jadhav	Blue Flame Labs Ltd.

Object Oriented Programming (Lab)

Dr. Kalpana Metre	ITMBU,Vadodara,Gujrat
Dr. Prashant Yawalkar	MET's Institute of Engineering
Dr. Archana R. Panhalkar	Amrutvahini College of Engineering, Sangamner
Dr. Dipannita Mondal	Dr. D.Y. Patil College of Engineering and Innovation, Talegaon, Pune
Dr. Amit A. Kadam	ABMSP's Anantrao Pawar College of Engineering & Research, Pune
Prof. Shubhangi Said	Jaihind College of Engineering, Kuran

Digital Electronics and Logic Design	
Dr. Shraddha Pandit	Modern COE,Pune
Dr Chaya Ravi Jadhav	Dr D Y.Patil institute of technology pimpri pune
Dr. Sanjaykumar Pingat	SKNCOE, VADGAON (Bk) , PUNE
Dr. Deepali Newaskar	RMD Sinhgad School of Engineering
Dr. Yogendra Patil	MMIT Lohgaon Pune
Mrs Geetanjali Mohole	JES Institute of Technology Management and Research Nashik

Embedded Systems	
Dr. Shraddha Pandit	Modern COE,Pune
Dr.S.P.Khedkar	MES Wadia College of Engineering Pune
Dr. Mahesh Wankhade	Sinhgad College of Engineering
Mr. Jagdish Kapadnis	PVGs College of Engineering & SSD IoM,Nashik
Mrs Devyani J Bonde	MMIT
Prof. Charushila D Patil	Guru Gobind Singh College of Engineering and Research Center, Nashik

Project Management	
Prof. Vinay S. Nalawade	S B Patil College of Engineering,Indapur
Dr. Manjusha Tatiya	Indira College of Engineering and Management
Dr. Sarita Patil	G H Raisoni College of Engineering and Management Wagholi pune
Dr. Shital Ashok Pawar	Bharati Vidyapeeth's College of Engineering for Women, Pune
Dr. Monika Rokade	Sharadchandra Pawar college of Engineering
Mrs. Shweta A Joshi	Trinity Academy of Engineering

Digital Finance	
Dr. Girish Potdar	Pune Institute of Computer Technology
Prof. Prasad A Lahare	PVG,Nashik
Dr.Minakshi P Atre	PVG,Pune
Prof.Vikram K Abhang	AVCOE,Sangamner
Prof. Satyajit S Nimbalkar	SVPM's COE,Malegaon(Bk),Baramati
Dr. Deepankar Roy	NIBM,Pune

Technology Commercialization & Startup Development	
Dr. Kalpana Metre	ITMBU,Vadodara,Gujrat
Prof. Nilesh Bhojane	Sinhgad COE,Pune
Prof. Ravindra P Aher	KBTCOE,Nashik
Prof. Shubham D Shelke	Samarth COEM,Belhe
Prof. Pankaj B Devre	MIT Academy of Engineering, Alandi, Pune
Prof. Sachin S. Bhanwase	ShivMani InfoTech Pvt.Ltd.,Pune

Technology Commercialization and Startup Development	
Dr. Kalpana Metre	ITMBU,Vadodara,Gujrat
Dr. Manohar Kodmelwar	VIIT,Pune
Dr. Prerana N Khairnar	SVIT,Nashik
Mrs.Shubhangi W Halkunde	MET's Institute of Engineering Nashik
Prof. Pradip P Ghorpade	VPKBIET,Baramati
Mr. Sharad Ramdas Kale	Shoption Private Limited

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Dr. Nilesh Uke - Board of Studies Computer Engineering

Savitribai Phule Pune University, Pune

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Dr. Pramod Patil - Dean – Science and Technology
Savitribai Phule Pune University, Pune

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