

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

&

**Computer Science and Engineering (Artificial
Intelligence)**

(With effect from Academic Year 2025-26)

Final Version - 18/06/2025

Contents

Abbreviations	4
Preface by Board of Studies	1
Program Educational Objectives	2
Knowledge and Attitude Profile	3
Program Outcomes	4
General Rules	6
Curriculum Structure - Semester III	9
Curriculum Structure - Semester IV	10
Semester III Courses	11
Data Structures	12
Artificial Intelligence	15
Operating System	18
Data Structures Laboratory	21
Artificial Intelligence Lab	25
Open Elective I - Financial Accounting	28
Open Elective I - Digital Finance	30
Open Elective I - Digital Marketing	33
Multi disciplinary Minor- Digital Electronics and Logic Design	35
Entrepreneurship Development	38
Universal Human Values and Professional Ethics	44

Community Engagement Project	50
Semester IV Courses	54
Database Management System	55
Data Science	58
Probability and Statistics	61
Database Management Systems Laboratory	64
Data Science Laboratory	70
Open Elective II - Project Management	74
Open Elective II - - Business Analytics	76
Open Elective II - Financial Management	78
Multi disciplinary Minor - Embedded Systems	82
Object Oriented Programming	85
Modern Indian Languages- Marathi	90
Modern Indian Languages - Hindi	92
Technology Commercialization and Startup Development	94
Environmental Studies	98
Acknowledgement	101

Nomenclature

AEC Ability Enhancement Course

AIDS Artificial Intelligence and Data Science

CEP Community Engagement Project

MDM Multidisciplinary Minor

OE Open Elective

PCC Program Core Course

VEC Value Education Course

VEC Value Education Course

VSEC Vocational and Skill Enhancement Course

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 AIDS and CSE(AI) 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 (AI) and Data Science (DS) 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, practical skills. This curriculum is meticulously crafted to provide a holistic learning experience, blending theoretical concepts with hands-on applications. It aims to foster critical thinking, problem-solving abilities, enabling graduates to contribute meaningfully to the advancement and responsible deployment of AI technologies. The revised syllabus falls in line with the objectives of NEP-2020, Savitribai Phule Pune University, AICTE New Delhi, 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. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. 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

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Second Year Artificial Intelligence and Data Science and Computer Science and Engineering (Artificial Intelligence)

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:** To create, and apply the techniques of AI and Data Science to forecast future events in the domain of Healthcare, Education, and Agriculture, Automation , Transport etc

Programme Educational Objectives

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.

Second Year Artificial Intelligence and Data Science and Computer Science and Engineering (Artificial Intelligence)

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.

**Second Year Artificial Intelligence and Data Science and Computer Science and Engineering
(Artificial Intelligence)**

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.

General Rules and Guidelines

- **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) of 30 marks based on all the Units of course syllabus to be scheduled and conducted at institute level. To design a Comprehensive Continuous Evaluation (CCE) scheme for a theory subject of 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

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:** 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.

Curriculum Structure - Semester III

Second Year Engineering (2024 Pattern) – Artificial Intelligence and Data Science and Computer Science and Engineering (Artificial Intelligence)

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 Lab	-	-	4	-	-	25	50		75	-	-	2	2
PCC-205-AID	Program Core Course	Artificial Intelligence Lab	-	-	2	-	-	25	-	25	50	-	-	1	1
OEL-220-AID	Open Elective	Open Elective I	2	-	-	15	35	-	-	-	50	2	-	-	2
MDM-230-AID	Multi disciplinary Minor	Digital Electronics and Logic Design	2	-	-	30	70	-	-	-	100	2	-	-	2
EEM-240-AID	Entrepreneurship/Management	Entrepreneurship Development	-	1	2	-	-	25	-	-	25	-	1	1	2
VEC-250-AID	Value Education Course	Universal Human Values and Professional Ethics	2	-	-	15	35	-	-	-	50	-	-	-	2
CEF-260-AID	Community Engagement Project	Community Engagement Project	-	-	4	-	-	25	-	25	50	-	-	2	2
Total			14	1	12	150	350	100	50	50	700	15	1	6	22

Open Elective I

OEL-220A-AID	Financial Accounting
OEL-220B-AID	Digital Finance
OEL-220C-AID	Digital Marketing

Second Year Engineering (2024 Pattern) – Artificial Intelligence and Data Science and Computer Science and Engineering (Artificial Intelligence)

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-206-AID	Program Core Course	Database Management systems	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-207-AID	Program Core Course	Data Science	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-208-AID	Program Core Course	Probability & Statistics	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-209-AID	Program Core Course	Database Management Lab	-	-	2	-	-	25	25	-	50	-	-	1	1
PCC-210-AID	Program Core Course	Data Science Lab	-	-	2	-	-	-	-	25	25	-	-	1	1
OEL-221-AID	Open Elective	Open Elective II	2	-	-	15	35	-	-	-	50	2	-	-	2
MDM-231-AID	Multi Disciplinary Minor	Embedded Systems	2	-	-	30	70	-	-	-	100	2	-	-	2
VSE-270-AID	Vocational and Skill Enhancement	Object Oriented Programming	-	-	4	-	-	25	25	-	50	-	-	2	2
AEC-281-AID	Ability Enhancement Course	Modern Indian Language	-	1	2	-	-	50	-	-	50	-	1	1	2
EEM-241-AID	Entrepreneurship /Economics	Technology Commercialization & Startup Development	-	1	2	-	-	25	-	-	25	-	1	1	2
VEC-251-AID	Value Education Course	Environmental Studies	2	-	-	15	35	-	-	-	50	2	-	-	2
Total			14	2	12	150	350	125	50	25	700	14	2	6	22

Open Elective II

OEL-221A-AID	Project Management
OEL-221B-AID	Business Analytical
OEL-221C-AID	Financial Management

Savitribai Phule Pune University, Pune



Maharashtra, India

SE - Artificial Intelligence and Data Science & SE - Computer Science and Engineering (Artificial Intelligence)

Semester - III

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science and Computer Science and Engineering (Artificial Intelligence) (2024 Course)		
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: **Analyze** and **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- Floyd-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, 2nd edition, 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: 97881317114

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 and Computer Science and Engineering (Artificial Intelligence) (2024 Course)		
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: **Understand** 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 and Computer Science and Engineering (Artificial Intelligence) (2024 Course)		
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.

Cast 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 Course)		
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	<p>Write menu based program-</p> <p>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.</p> <p>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.</p>
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	<p>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:</p> <p>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.</p>
OR	
	<p>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-</p> <p>a) Set of students who like both vanilla and butterscotch</p> <p>b) Set of students who like either vanilla or butterscotch or not both</p> <p>c) Number of students who like neither vanilla nor butterscotch</p>
5	<p>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</p> <p>a) The list of available seats is to be displayed b) The seats are to be booked c) The booking can be cancelled.</p>
OR	
	<p>Write a program to implement doubly linked list</p> <p>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)</p>
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 and Computer Science and Engineering (Artificial Intelligence) (2024 Course)		
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: **Construct** and **analyze** basic neural network models for classification tasks, including the use of activation functions.

Course Contents

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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.

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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:9788126579945
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 and Computer Science and Engineering (Artificial Intelligence) (2024 Course)		
OEL-220A- AID : Financial Accounting		
Teaching /scheme	Credits	Examination Scheme
Theory : 02 Hours/Week	02	CCE : 15 Marks End-Semester: 35 Marks

Course Objectives: The course aims to:

1. To build upon the foundational knowledge of financial accounting.
2. To develop a deeper understanding of the theoretical underpinnings of financial reporting.
3. To enable students to analyze and interpret financial statements for decision-making purposes.
4. To introduce students to specialized accounting topics relevant to various industries.

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

- CO1: **Analyze** and apply accounting standards related to specific assets, liabilities, and equity.
- CO2: **Prepare** financial statements for different types of business entities, including corporations.
- CO3: **Evaluate** the impact of various accounting methods on financial statements.
- CO4: **Apply** accounting principles to specialized topics such as branch accounting, lease accounting and intangible assets.
- CO5: **Interpret** financial statements and use accounting information for decision-making.

Course Contents

Unit I - Accounting for Assets (07 Hours)

Property, Plant, and Equipment (PP&E): Acquisition, cost determination, and capitalization, Depreciation methods (straight-line, reducing balance, units of production), Impairment of assets (concepts and accounting treatment), Accounting for disposals and exchanges. Relevant Accounting Standards (AS 10, IAS 16).

Inventory: Inventory costing methods (FIFO, LIFO, weighted average), Lower of cost or net realizable value (LCNRV), Inventory systems (periodic and perpetual), Relevant Accounting Standards (AS 2, IAS 2).

Unit II - Accounting for Liabilities and Equity (07 Hours)

Liabilities: Accounting for current liabilities (accounts payable, short-term debt), Accounting for long-term liabilities (bonds payable, loans), Concepts of provisions, contingent liabilities, and contingent assets (e.g., AS 29, IAS 37).

Equity: Share capital: Types of shares, issue, forfeiture, and reissue of shares, Accounting for share issue, buyback, and bonus shares, Dividends: Types, declaration, and payment.

Unit III - Corporate Accounting - (08 Hours)

Accounting for share capital and debentures, Preparation of company final accounts Introduction to cash flow statements (basic concepts and preparation as per AS 3 or IAS 7), Understanding and accounting for share buyback, Accounting for bonus shares and rights issue, Introduction to interim and final dividends.

Unit IV Special Accounting Topics (08 Hours)

Branch Accounting: Accounting for dependent branches, Accounting for independent branches and reconciliation.

Lease Accounting: Types of leases (operating and finance leases), Accounting treatment for operating and finance leases.

Intangible Assets: Recognition, measurement, and amortization of intangible assets (patents, trademarks, goodwill, etc), Impairment of intangible assets, Accounting for research and development costs (AS 26, IAS 38, etc).

Learning Resources

Text Books:

1. S.N. Maheshwari and S.K. Maheshwari, "Advanced Accountancy "12th Edition, S. Chand and Company.
2. R.L. Gupta and M. Radhaswamy, "Corporate Accounting", 15th Edition, S. Chand and Company.

Reference Books:

1. Subramanyam and Wild, "Financial Statement Analysis handbook", Zebralearn publication.
2. Benjamin Graham and Charles McGolrick, " Interpretation of Financial Statements", Harper Business.
3. Relevant Accounting Standards issued by ICAI/ IASB.

MOOC / NPTEL/YouTube Links: -

1. Institute of Chartered Accountants of India (ICAI): <https://www.icai.org/>
2. International Accounting Standards Board (IASB): <https://www.ifrs.org/>
3. Securities and Exchange Board of India (SEBI): <https://www.sebi.gov.in/>
4. Financial Accounting Standards Board (FASB): <https://www.fasb.org/>
5. Accounting Tools: <https://www.accountingtools.com/>

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science and CSE (Artificial Intelligence) (2024 Course)		
OEL- 220B- AID : Digital Finance		
Teaching /scheme	Credits	Examination Scheme
Theory : 04 Hours/Week	02	CCE : 15 Marks End-Semester: 35 Marks

Prerequisite Courses, if any :

1. Basic Finance and Economics
2. Cyber Security & Digital Payments

Companion Course if any: NA

Course Objectives: The course aims to:

1. The evolution of digital finance and the influence of big data on financial systems.
2. Digital payment ecosystems and ongoing transformations in digital banking.
3. Core concepts of blockchain, cryptocurrencies, and decentralized finance.
4. Applications of AI, machine learning, and analytics in financial services.
5. Cybersecurity concerns, financial risk factors, and regulatory developments in digital finance.

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

- CO1 - Grasp the basics of digital finance, big data, and regulatory frameworks
- CO2 - Analyze digital payments, FinTech trends, and neo-banking models.
- CO3- Illustrate blockchain, cryptocurrencies, and DeFi systems.
- CO 4- Discuss the role of AI/ML for financial analytics.
- CO5 - Explore cybersecurity and compliance strategies for digital finance.

Course Contents

Unit I - Digital Finance Fundamentals & Big Data (07 Hours)

Evolution & Fundamentals of Digital Finance: Evolution of digital finance and the shift from traditional to digital systems. Introduction to FinTech and technological transformations in financial services. Overview of regulatory frameworks and compliance in the digital era.

The Rise of Big Data in Finance: Role of big data in shaping financial decision-making and risk management. Leveraging data science for personalization and modern financial services

Case Study: DBS Bank's Digital Transformation

Unit II - Digital Payment Systems & Digital Banking Transformation (07 Hours)

Digital Payment Ecosystems: Historical evolution and digitalization of payment systems (ECS, RTGS, NEFT, IMPS, UPI, mobile wallets, contactless payments), Attributes of a well-functioning payment system and the role of banks.

Fintech Innovations & Disruption: FinTech startups, challenger banks, and peer-to-peer lending models, FinTech applications across banking, NBFCs, insurance, lending, audit, and compliance, Regulatory guidelines (e.g., RBI guidelines) and risks associated with new payment models. The Future of Digital Banking: How traditional banks are adapting and the rise of neo-banks, Digital banking trends and evolving customer expectations

Case Study : Unified Payments Interface (UPI) in India

Unit III - Blockchain, Cryptocurrencies & Decentralized Finance (08 Hours)

Blockchain Technology: Fundamentals of blockchain and underlying cryptographic techniques, Smart contracts and decentralized finance (DeFi) applications. **Cryptocurrencies & Digital Assets:** Overview and evolution of cryptocurrencies (Bitcoin, Ethereum, etc.), Central Bank Digital Currencies (CBDCs) and other emerging digital assets. Advanced Applications & Case Studies: Impact of blockchain on payments, lending, and financial settlements, Real-world case studies and disruptive potential in global finance

Case study: The Sand Dollar (Bahamas' CBDC)

Unit IV - Artificial Intelligence, Machine Learning & Financial Analytics (08 Hours)

AI & Machine Learning in Finance: Predictive analytics in stock markets, trading, and algorithmic/high-frequency trading, Credit risk analysis and automated decision-making using AI.

Data Analytics & Financial Applications: Data sourcing, cleaning, processing, and visualization for financial data, Sentiment analysis and AI-driven portfolio management.

Practical Projects & Case Studies: Hands-on projects: building stock price prediction models, fraud detection systems, and credit score prediction models, Real-world applications in digital lending and wealth management

Case study : Thread programming Using Pthreads, POSIX

Learning Resources

Text Books

1. C. Skinner, Digital Finance: Big Data, Startups, and the Future of Financial Services, 1st ed. Hoboken, NJ, USA: Wiley, 2016.
2. J. H. M. T. Jeffry, Introduction to FinTech, 1st ed. Noida, India: Pearson Publications, 2018
3. D. Tapscott and A. Tapscott, The Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies is Changing the World, 1st ed. New York, NY, USA: Penguin Random House, 2016.
4. M. López de Prado, Machine Learning for Asset Managers, 1st ed. Cambridge, UK: Cambridge University Press, 2020.

5. "FinTech: The Impact and Role of Financial Technology" by Parag K. Patel, Wiley publications, 1st edition

Reference Books:

1. R. Ghose, Future Money: Fintech, AI and Web3. London, UK: Kogan Page, 2024.
2. Y. Hilpisch, Artificial Intelligence in Finance: A Python-Based Guide, 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2020.
3. M. López de Prado, Advances in Financial Machine Learning, 1st ed. Hoboken, NJ, USA: Wiley, 2018.
4. S. Chishti and J. Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs, and Visionaries, 1st ed. Hoboken, NJ, USA: Wiley, 2016.
5. D. Drescher, Blockchain Basics: A Non-Technical Introduction in 25 Steps, 1st ed. Berkeley, CA, USA: Apress, 2017.
6. B. Hines, Digital Finance: Security Tokens and Unlocking the Real Potential of Blockchain, 1st ed. Hoboken, NJ, USA: Wiley, 2020.

E-Books

1. P. H. Beaumont, Digital Finance: Big Data, Start-ups, and the Future of Financial Services, 1st ed. London, U.K.: Routledge, 2019. Link: <https://download.e-bookshelf.de/download/0015/1963/23/G-0015196323-0047264745.pdf>
2. N. Urbach and M. Röglinger, Big Data and Artificial Intelligence in Digital Finance, 1st ed. Cham, Switzerland: Springer, 2022 Link: <https://library.oapen.org/bitstream/id/fefe46c7-4495-49ba-bcab-9cf1851e81e6/978-3-030-94590-9.pdf>
3. L. Perlman, An Introduction to Digital Financial Services, 1st ed., 2018. Link: https://www.academia.edu/38444444/An_Introduction_to_Digital_Financial_Services

MOOC / NPTEL/YouTube Links:

1. <https://www.my-mooc.com/en/mooc/introduction-to-fintech/>
2. <https://mooc.besideproject.eu/courses/blockchain-use-cases-in-digital-finance/>
3. <https://www.coursera.org/specializations/digital-transformation-financial-services>

Savitribai Phule Pune University		
Second Year of Computer Engineering and Computer Science and Engineering (2024 Course)		
OEL-220C AID : Digital Marketing		
Teaching Scheme	Credits	Examination Scheme
Theory : 02 Hours/Week	02	CCE : 15 Marks End-Semester: 35 Marks

Companion Course : Information and Cyber Security Laboratory

Course Objectives: The course aims to:

1. To understand the basic Concepts of Digital marketing and the road map for successful Digital marketing strategies.
2. To know the importance of Social Media Platforms importance in Digital Marketing
3. To understand the technological importance of Search Engine Optimization (SEO)

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

- CO1: **Learn** and **understand** the basic Concepts of Digital marketing
- CO2: **Apply** digital marketing tools for suitable applications
- CO3: **Examine** the various social media and design Advertising campaigns
- CO4: **Learn** search engine optimization (SEO) techniques and **apply** it for suitable application to increase page views.
- CO5: **Explore** YouTube Digital Advertising

Course Contents

Unit I - Introduction to Digital Marketing (07 Hours)

Fundamentals of Digital marketing & Its Significance, Traditional marketing Vs Digital Marketing, Evolution of Digital Marketing, Digital Marketing Landscape, Key Drivers, The Digital users in India, Digital marketing Strategy- Consumer Decision journey Digital advertising Market in India, Skills in Digital Marketing, Digital marketing Plan.

Unit II - Digital Marketing Terminology (07 Hours)

Terminology used in Digital Marketing, PPC and online marketing through social media, Social Media Marketing, Google web-master and analytics overview, Email Marketing, Mobile Marketing Display advertng, Buying Models, different type of ad tools, Display advertising terminology, types of display ads, different ad formats

Unit III - Social Media Marketing (08 Hours)

Fundamentals of Social Media Marketing& its significance, Necessity of Social media Marketing Facebook Marketing: Facebook for Business, Facebook Insight, Different types of Ad formats, setting up Facebook Advertising Account, Facebook audience & types, Designing Facebook Advertising campaigns, Facebook Avatar, Apps, Live, Hashtags

Unit IV - Search Engine Optimization (SEO) (08 Hours)

Introduction to SEO, How Search engine works, SEO Phases, History Of SEO, How SEO Works, Googlebot (Google Crawler), Types of SEO technique, Keyword Planner tools
Social media Reach- Video Creation & Submission, Maintenance- SEO tactics, Google search Engine

Learning Resources

Text Books:

1. V. Ahuja, Digital Marketing, Oxford University Press
2. D. Ryan, C. Jones, "Understanding Digital Marketing Strategies for Engaging the Digital Generation", Koganpage Publication, (2nd Edition)
3. Chinmay Kamat, Nitin Kamat, "Digital Marketing", Himalaya Publishing House, (2nd Edition)

Reference Books:

1. H. Annmarie , A. Joanna, "Quick win Digital Marketing", Paperback edition, Oak Tree Press
2. Seema Gupta, "Digital Marketting", Mc Graw Hill (3d Edition)

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science and Computer Science and Engineering (Artificial Intelligence) (2024 Course)		
MDM-230-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), Presetable 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 (Unit 3)
2. D. Leach, Malvino, Saha, —Digital Principles and Applications||, Tata McGraw Hill, ISBN – 13:978-0-07-014170-4.(Unit 1,2,3)
3. Anil Maini, —Digital Electronics: Principles and Integrated Circuits||, Wiley India Ltd, ISBN:978-81-265-1466-3.(Unit 1,2,3)
4. Norman B & Bradley, —Digital Logic Design Principles, Wiley India Ltd, ISBN:978-81-265-1258 (Unit 1,2,3)
5. Safwat Zaky,—Computer Organization , 5th edition Tata McGraw Hill (Unit 4)
6. William Stallings,—Computer Organization & Architecture Designing for Performance, , Pearson (Unit 4)
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.nptel.ac.in/noc19_ee5

• **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 and Computer Science and Engineering (Artificial Intelligence) (2024 Course)		
EEM-240- AID : Entrepreneurship Development		
Teaching /scheme	Credits	Examination Scheme
Tutorials : 01 Hour/Week	01	Term Work : 25 Marks
Practical : 02 Hours/Week	01	

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 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.

Feasibility Analysis Basics: Market Need Assessment: about the users, the problem complexity. Scalability Check: Geographically or vertically growth of the idea, Barriers to scaling. Introduction to the “Lean Canvas”.

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

Retention vs. Acquisition – Importance of building long-term customer relationships.

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/@wadhvani-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.	<p>Write a reflective essay (500–600 words) based on the following:</p> <ul style="list-style-type: none"> • 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 and 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.	<p>Generate 10 Business Ideas</p> <p>Use any structured brainstorming technique</p> <p>Ideas can be tech-based, social impact, service-based, or product-based</p> <p>2. Select One Idea- Choose the most promising idea from your list</p> <p>3. Write a 1-page Concept Summary, include the following:</p> <ul style="list-style-type: none"> • 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.	<p>Part A: Business Model Canvas</p> <p>1. Choose a business idea (from Assignment 2 or a new one)</p> <p>2. Create a Business Model Canvas with all 9 key blocks:</p> <ul style="list-style-type: none"> 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 <p>3. Present the BMC in visual or tabular format.</p>
			<p>Part B: Customer Interviews & Insights</p> <p>1. Identify 2–3 potential customers from your target segment</p> <p>2. Conduct brief interviews (5–10 minutes each) to gather information on:</p> <ul style="list-style-type: none"> o Their pain points o Their reaction to your proposed solution o Willingness to pay or use your product/service <p>3. Summarize findings in a 1–1.5 page report that includes:</p> <ul style="list-style-type: none"> o Key customer quotes or paraphrased insights o A revised Value Proposition or Customer Segment block (if applicable) o A short reflection: key learnings and potential changes to the business model

4	Business Launch Plan – Marketing & Financial Snapshot	To develop a practical understanding of how marketing strategy 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.	<p>You are preparing to launch your business idea. Prepare a c Marketing and Financial Snapshot including the following</p> <p>Part A: Marketing Campaign Plan</p> <ul style="list-style-type: none"> • Define your target market by identifying primary customer • Design a mini-campaign using one or more of the following channels: <p>Social media (e.g., Instagram, LinkedIn)</p> <p>Print/digital flyers</p> <p>Email marketing</p> <ul style="list-style-type: none"> • Describe the campaign content, including the message or be promoted. • Optionally, create 1–2 sample marketing materials. • Write a 300-word explanation outlining your marketing s and expected impact. <p>Part B: Financial Snapshot</p> <ol style="list-style-type: none"> 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.	<p>Prepare a 90-second elevator pitch for your business ide same or refined idea used in earlier assignments).</p> <p>Your pitch should cover the following elements:</p> <ul style="list-style-type: none"> 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 <p>Deliver Your Pitch:</p> <ul style="list-style-type: none"> o Record a video and submit it with written version of your o Ensure clear speech, confident body language (for video), persuasive tone. <p>Reflection (Short Write-up):</p> <ul style="list-style-type: none"> o Share what you learned about communicating your idea o Describe challenges or rewards you experienced in the pr

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science and CSE (Artificial Intelligence) (2024 Course)		
VEC-250-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.in/>
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/106/101/201901/>

E-Resources: -

1. <https://fdp-si.aicte-india.org/download.php#1/>
2. <https://madhyasth-darshan.info/postulations/knowledge/knowledge-of-humane-conduct/>
3. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

Guidelines for Continuous Assessment

Considering the specific nature of this course, the methodology is exploration based and thus universally adaptable. In order to connect the content of this course with practice, minimum two group activities must be conducted with active involvement of the students. 50 % of the continuous assessment should be strictly based on the participation of the students in the following activities.

Sr	Objectives	Expected Outcome
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1	Sharing about Oneself : Introduction of students with following points yourself, family, friends, achievements and failures, your aspirations from life. How do you expect to fulfil these aspirations and live a life of fulfillment?	The students start exploring themselves; get comfortable with each other and with the teacher and start appreciating the need and relevance of the course.
2	Exploring Human Consciousness Watch and discuss the documentary video “Story of Stuff”. It is about the materials economy – its motivation, process and outcome. (Source: http://storyofstuff.org/movies/story-of-stuff)	The students start finding that right understanding is the basic need of human being; followed by relationship and physical facility. They also start feeling that lack of understanding of human values is the root cause
3	Exploring right understanding Make a list of your desires. Now for each item on the list, find out what would be necessary to fulfil it, i.e. will it require: (a) Right understanding? (b) Relationship (right feeling)? (c) Physical facility?	Students start feeling that lack of understanding of human values is the root cause of all problems and the sustained solution could emerge only through understanding of human values and value-based living.
4	Exploring Natural Acceptance Observation within the faculty of ‘Natural Acceptance’, based on which you can verify what is right or what is not right for you. Make a list of the problems in your family. For each problem, find out the most significant reason: is it related to lack of right understanding, lack of feelings in relationship or lack of physical facility? Also, find out how much time and effort you have devoted for each in the last one week.	The students are able to see that self-verification must be based on their natural acceptance. In many cases, their actual living is not in accordance with their natural acceptance. In addition, lack of feeling in relationship is the major cause of problems in their family and with friends.
5	Exploring the difference of Needs of Self and Body Take the list of desires you made in Practical 2. Update it if required. Now classify the desires as being related to the need of the Self or need of the Body	The students are able to relate their desires to need of the Self and the Body distinctly. They are able to see that the Self and the Body are two distinct realities, and large parts of their desires are related to the need of the Self (and not the Body).

6	<p>Exploring Sources of Imagination in the Self</p> <p>Recall the times that your body has been ill (in disharmony) in the last 3 years. What steps were taken to restore the harmony of the Body? If you were to take full responsibility for your body, (i.e. you had the feeling of self-regulation), what kind of daily schedule would you have? Approximately how much time would you allocate for keeping your body in good health?</p>	<p>The students are able to list down activities related to proper upkeep of the Body and practice them in their daily routine. They are also able to appreciate the plants growing in and around the campus, which can be beneficial in maintaining their health and even curing common ailments.</p>
7	<p>Exploring the Feeling of Trust</p> <p>Show & discuss the video “Right Here Right Now”. It is a short film directed by Anand Gandhi about human behaviour and its propagation.</p> <p>https://www.youtube.com/watch?v=OVAofqQ00PM https://www.youtube.com/watch?v=gIYJbP1kUjE</p>	<p>The students are able to see that the natural acceptance (intention) of everyone is to be happy and make others happy! It is the competence is lacking in themselves and in others. They are able to distinguish between reaction and response, appreciate the need for a proper response in human-human interaction and make an effort towards it.</p>
8	<p>Exploring the Feeling of Respect</p> <p>List out ten or more of your interactions with other people in your family and friends in the last one week. Now analyse these interactions were over-evaluation, under/ otherwise evaluation or right evaluation of the other? In each interaction, were you comfortable within, uncomfortable within or unaware of your state?</p>	<p>The students are able to see that respect is the right evaluation (of intention and competence). Only right evaluation leads to fulfillment in relationship. Over evaluation leads to ego and under/otherwise evaluation leads to depression.</p>
9	<p>Exploring Systems to fulfil Human Goal</p> <p>Assuming that you would like to see your hostel/ educational institution/ workplace/ neighborhood as a model of human society, write down its goal(s) and the system to achieve these goals.</p>	<p>The students are able to see that as a family, a society, the comprehensive human goal is naturally acceptable to all. They are able to see that the systems required for their fulfilment include; Education-Sanskar, Health-Self regulation, Production-Work, Justice-Preservation and Exchange-Storage. Meaningful participation by every individual, every family, every family cluster... every village, town, city... country and the whole world is required in these systems for the human goals to be fulfilled.</p>

10	Exploring the Four Orders of Nature Watch and discuss the documentary video “An Inconvenient Truth”. It is about global climate change presented by Former US Vice President Al Gore. He raises the question “What were you doing when you had the time to do something?” (Source: http://an-inconvenient-truth.com/)	The students are able to appreciate the interconnectedness, interdependence and the relationship of mutual fulfilment existing in nature. They are able to see that they have a natural acceptance to participate in a mutually fulfilling manner in nature.
11	Exploring Co-existence in Existence Observe your Self. Are you in space? Are you getting energy from the body? Is your energy dependent on the body? When your body is sick, does your energy to think diminish? Are you energized in space? Is the body dictating you? Are you self-organized in space?	The students are able to obtain a holistic vision about the existence. It is in the form of co-existence, rather than a chaos. Every unit is energized, self-organized and is participating with other units in an orderly manner for mutual-fulfilment. It is only the human being without right understanding, which is violating this underlying co-existence. They are able to appreciate the need to understand the co-existence in existence.

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science and CSE (Artificial Intelligence) (2024 Course)		
CEF-260- 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.

Course Contents

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/Green 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

&

**SE - Computer Science and Engineering (Artificial
Intelligence)**

Semester IV

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science and CSE (Artificial Intelligence) (2024 Course)		
PCC-206- 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 Query 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”, Emereopt 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 and CSE (Artificial Intelligence) (2024 Course)		
PCC-207- AID: Data Science		
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. 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 (09 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 (09 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 (09 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 (09 Hours)

Data Preprocessing, Data Cleaning: Handling missing data, outliers. - Data Transformation Techniques: Feature Extraction and Selection (PCA), encoding. - Exploratory Data Analysis (EDA): Uni-

variate, 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 (09 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 and CSE (Artificial Intelligence) (2024 Course)		
PCC-208- AID: Probability and Statistics		
Teaching /scheme	Credits	Examination Scheme
Theory : 02 Hours/Week	02	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

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 (06 Hours)
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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 (06 Hours)
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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 (06 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 (06 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 (06 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-qNVok>
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 and CSE (Artificial Intelligence) (2024 Course)		
PCC-209- 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/ 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.

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
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	<p>Objective: Set up and create a database using MySQL/PostgreSQL.</p> <p>Task:</p> <p>Entities and Relationships:</p> <ul style="list-style-type: none"> • Student (StudentID, Name, Email, Age, Address) • Course (CourseID, CourseName, Credits, InstructorID) • Instructor (InstructorID, Name, Email, Department) • Enrollment (EnrollmentID, StudentID, CourseID, EnrollmentDate) <p>Relationships:</p> <ul style="list-style-type: none"> • A student can enroll in multiple courses. • A course can have multiple students. • An instructor teaches one or more courses.
2	<p>Views and Indexing</p>
	<p>Optimizing a Student Course Management System with Views and Indexing for Faster Query Performance.</p> <p>Objective: Understand views and indexing for performance optimization.</p> <p>Task:</p> <ul style="list-style-type: none"> • 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	<p>SQL Queries with Filters and Sorting</p> <p>Advanced Querying in a Student Course Management System Using Filters, Sorting, and Nested Subqueries</p> <p>Objective: Use SQL filters and sorting clauses.</p> <p>Task:</p> <ul style="list-style-type: none"> • 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	<p>Multi-Table Joins</p> <p>Develop a Customer Order Management System to Retrieve Data Using SQL Joins</p> <p>Objective: Learn inner and outer joins in SQL.</p> <p>Task:</p> <ul style="list-style-type: none"> • 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	<p>PL/SQL Procedures and Functions</p> <p>Design and Implement a Sales Management System with Stored Procedures and Functions for Efficient Data Handling</p> <p>Objective: Implement stored procedures and functions.</p> <p>Task:</p> <ul style="list-style-type: none"> • Create a stored procedure to add data to a table. • Create a function to calculate and return total sales.
6	<p>Triggers and Cursors</p> <p>Develop an Employee Management System with Triggers for Audit Logging and Cursors for Efficient Data Processing</p> <p>Objective: Implement triggers and cursors in PL/SQL.</p> <p>Task:</p> <ul style="list-style-type: none"> • 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	<p>NoSQL Database Introduction – MongoDB Aggregation and Indexing</p> <p>Objectives: Work with MongoDB for NoSQL data storage.</p> <p>Use MongoDB aggregation and indexing for data analysis.</p> <p>Task:</p> <ul style="list-style-type: none"> • 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	<p>Case Study – Social Media Data Processing using NoSQL</p> <p>Objective: Process unstructured social media data using NoSQL databases.</p> <p>Task:</p> <ul style="list-style-type: none"> • Import a dataset with social media posts into MongoDB. • Write queries to filter and analyze data (e.g., find top trending hashtags).
9	<p>MySQL Database Backup and Recovery</p> <p>Objective: To understand and practice the process of taking a backup of a MySQL database to ensure data security and disaster recovery.</p>
10	<p>Compulsory Mini Project (Group of 2 to 3 students can develop mini project)</p> <p>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.</p>
	<p>1. Library Management System</p> <p>Objective: Design a relational database to manage books, users, loans, and overdue notifications.</p> <p>Features: • Book search with filters • User login and role-based access • Loan and return history management</p>
	<p>2. Online Retail Store Database</p> <p>Objective: Develop a database for an e-commerce store to manage products, customers, orders, and inventory.</p> <p>Features: • Order placement and status tracking • Real-time inventory updates • Customer order history</p>
	<p>3. Student Attendance and Grade Management System</p> <p>Objective: Create a database for managing student attendance and grades for courses.</p> <p>Features: • Attendance recording and reporting • Grade calculation and storage • Performance analysis for students</p>

	<p>4. Hospital Patient Management System</p> <p>Objective: Design a database for managing patients, doctors, and appointments.</p> <p>Features: • Patient registration and medical history tracking • Doctor schedules and appointment booking</p> <ul style="list-style-type: none"> • Billing and prescription management
	<p>5. Movie Ticket Booking System</p> <p>Objective: Create a database for booking movie tickets with seat selection.</p> <p>Features: • Show listings and seat availability • Ticket booking and cancellation • Customer feedback collection</p>
	<p>6. Food Delivery System</p> <p>Objective: Design a database for managing restaurants, orders, and deliveries.</p> <p>Features: • Restaurant menu and order placement • Customer and delivery person management • Order tracking and delivery status</p>
	<p>7. Real Estate Property Management System</p> <p>Objective: Develop a system to manage properties, agents, and customers.</p> <p>Features: • Property listing with filters • Customer inquiries and appointments • Agent performance tracking</p>
	<p>8. Social Media Data Analysis using MongoDB</p> <p>Objective: Use a NoSQL database to analyze social media data such as user posts and hashtags.</p> <p>Features: • Hashtag trend identification • Sentiment analysis on user comments • Data aggregation for user engagement</p>
	<p>9. Online Voting System</p> <p>Objective: Create a secure database for managing elections and votes.</p> <p>Features: • Voter registration and verification • Voting and vote tallying • Result announcement and audit trail</p>
	<p>10. Event Management System</p> <p>Objective: Develop a database to manage events, participants, and schedules.</p> <p>Features: • Event registration and attendee tracking • Event schedules and notifications</p> <ul style="list-style-type: none"> • Feedback collection and reporting

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science and CSE (Artificial Intelligence) (2024 Course)		
PCC-210-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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Operating System recommended :- 64-bit Open source Linux or its derivative Programming tools recommended: - Python, tableau, Power BI etc.

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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)
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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	<p>Sales Performance Reporting Using Power BI</p> <p>Create an interactive Power BI report to analyze and visualize the sales performance of a fictional retail company.</p> <p>Dataset: https://www.kaggle.com/datasets/mohammadtalib786/retail-sales-dataset</p> <p>Report Requirements:</p> <p>Build a Sales Dashboard showing:</p> <ul style="list-style-type: none"> • Total Sales • Total Units Sold • Top 5 Products by Sales • Sales by Region (Map Visualization) • Monthly Sales Trend (Line Chart) <p>Add filters for: • Product Category • Region • Time Period</p> <p>Technical Requirements:</p> <ul style="list-style-type: none"> • 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	<p>HR Analytics Reporting Using Power BI</p> <p>Design a Power BI report to help the HR department monitor employee metrics and retention</p> <p>Dataset: https://www.kaggle.com/datasets/pavansubhasht/ibm-hr-analytics-attrition-dataset</p> <p>Report Requirements:</p> <ul style="list-style-type: none"> • 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) <p>Technical Requirements:</p> <ul style="list-style-type: none"> • 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	<p>Exploring Global COVID-19 Trends Using Tableau</p> <p>Dataset: https://www.kaggle.com/datasets/josephassaker/covid19-global-dataset</p> <p>Identify • trends in cases • deaths, • vaccinations across countries and continents.</p> <p>Create an interactive dashboard using fundamental Tableau skills such as chart creation, filtering, mapping, and layout design.</p>
4	<p>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]</p>

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science and CSE (Artificial Intelligence) (2024 Course)		
OEL-222A- AID: Project Management		
Teaching /scheme	Credits	Examination Scheme
Theory : 02 Hours/Week	02	CCE : 15 Marks End-Semester: 35 Marks

Prerequisite Courses, if any :

1. Programming and Problem Solving

Course Objectives: Students will be familiarized with

1. Fundamental principles of project management
2. Project planning, organizing, and controlling the projects
3. Skills in project scheduling, budgeting, and resource allocation
4. Risk management, quality control, and stakeholder management in projects
5. Project management concepts to real-world scenarios.

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

- CO1: Explain the principles of project management
- CO2: Use project management concepts to real-world scenarios
- CO3: Apply Agile Project Management
- CO4: Discuss the importance of risk management, quality control, and stakeholder management in projects
- CO5: Demonstrate skills in project planning, execution, and control

Course Contents

Unit I -Introduction to Project Management (07 Hours)

Project Definition, Project Life Cycle, processes and Knowledge areas in Project management, WBS and its types, introduction to PMBOK, portfolio Management, Traditional Vs Modern Project using PMBOK Concept

Case Study: Online Shopping

Unit II -Agile Software Development (07 Hours)

Introduction, Agile methods, Scrum, Comparison between Non Agile and Agile Project, Three stages of Agile Project, Plan driven and Agile development, Extreme programming, scaling agile methods, Roles and responsibilities, Scheduling and tracking.

Case Study : Analyze the same project using Agile. Create the three stages of the project

Unit III -Project Planning and Management (08 Hours)

Introduction to project planning, Project planning process, Agile project management, Gantt Chart, PERT chart, CPM, Microsoft Projects, and Primavera Project Management Software, Role of Project Manager, Objectives of Activity planning, Project Schedules, Activities, Sequencing and Scheduling,

Case study: Develop the Software project plan using Microsoft Projects or any open source tool like Jira, Kanban, extreme programming

Unit IV - Project Execution and Control (08 Hours)

Project execution: task assignment, tracking, and monitoring - Project control: schedule control, budget control, and quality control - Earned value management (EVM) and project performance measurement - Project reporting and communication

Risk management principles and concepts - Risk identification, analysis, and prioritization - Risk response planning and implementation - Risk monitoring and review

Learning Resources

Text Books:

1. "Project Management: The Managerial Process" by Erik W. Larson and Clifford F. Gray .
2. "Project Management: A Systems Approach to Planning, Scheduling, and Controlling" by Harold Kerzner
3. "Project Management for Engineering, Business, and Technology" by John M. Nicholas & Herman Steyn
4. Roger Pressman, "Software Engineering: A Practitioner's Approach", McGraw Hill, ISBN 0-07-337597-

Reference Books:

1. "A Guide to the Project Management Body of Knowledge (PMBOK Guide)" by Project Management Institute (PMI)
2. "The Fast Forward MBA in Project Management" by Eric Verzuh
3. Pankaj Jalote, "An Integrated Approach to Software Engineering", Springer, ISBN 13:9788173192715.
4. S K Chang, "Handbook of Software Engineering and Knowledge Engineering", World Scientific, Vol I, II, ISBN: 978-981-02-4973-1

MOOC / NPTEL/YouTube Links: -

1. https://onlinecourses.swayam2.ac.in/cec20_cs07/preview
2. https://onlinecourses.nptel.ac.in/noc24_mg01/preview

Online Links: -

- <https://www.atlassian.com/work-management/project-management>
- <https://www.atlassian.com/project-management>
- <https://ebookpdf.com/roger-s-pressman-software-engineering>

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science and CSE (Artificial Intelligence) (2024 Course)		
OEL-222B- AID: - Business Analytics		
Teaching /scheme	Credits	Examination Scheme
Theory : 02 Hours/Week	02	CCE : 15 Marks End-Semester: 35 Marks

Prerequisite Courses, if any :

1. Programming and Problem Solving

Course Objectives: Students will be familiarized with

- 1.

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

- CO1: **Recall** the fundamental concepts and terminologies in business analytics
- CO2: **Explain** the differences between business analytics and related fields (e.g., business analysis, business intelligence, data science), as well as the ethical considerations and quality of data in business analytics and key applications of business analytics
- CO3: **Utilize** basic tools of business analytics, such as data exploration and visualization tools, to perform basic exploratory data analysis and data cleaning tasks
- CO4: Break down business problems into key questions and analyze data to **derive** meaningful insights for decision-making in various business domains like marketing, finance, HR, operations, health care, and agribusiness
- CO5: **Assess** the effectiveness of different data-driven strategies and analytical techniques in improving business performance across different sectors through case studies

Course Contents

Unit I - Business Analytics Basics (07 Hours)

Definition of analytics, Evolution of analytics, The Growing Role of Business Analytics, Business analytics vs business analysis, Business intelligence vs Data Science, Data Analyst Vs Business Analyst, Types of Analytics - Descriptive, Diagnostic, Predictive, Prescriptive, Concept of insights. Importance of data in business analytics, Differences between data, information and knowledge, Quality of data, 5Vs of Big Data, Big Data Collection and Ethics, Data sources and collection methods, Data privacy, security, and ethical considerations

Unit II Analytical decision-making (07 Hours)

Analytical decision-making process, characteristics of the analytical decisionmaking process. Breaking down a business problem into key questions that can be answered through analytics, Characteristics of good questions, Skills of a good business analyst, The Basic Tools of Business Analytics - Data exploration and visualization (using tools like Excel, Tableau, or Power BI), Concept of

Statistical analysis and hypothesis testing (Hypothesis testing numerical / tests not expected) Data Visualization: Concept of Data Visualization, Popular Data Visualization tools, Exploratory Data Analysis(EDA), Data Cleaning, Data Inspection.

Unit III - Business Analytics in Marketing and Finance: (08 Hours)

Marketing Analytics, Customer segmentation, targeting, and positioning, Campaign management and ROI measurement, Data-driven marketing strategies. Financial Analytics

- Risk management and credit scoring, Financial forecasting and planning

Case studies: Financial performance improvement through analytics (Non-Statistical - Conceptual Treatment only).

Unit IV - Business Analytics in HR and Operations (08 Hours)

HR Analytics, Workforce planning and talent management, Employee engagement and performance measurement, Case studies: Enhancing HR practices with analytics. Operations Analytics - Process optimization and efficiency improvement, Supply chain analytics and logistics management

Case studies: Operational excellence through analytics Non-Statistical - Conceptual Treatment only).

Learning Resources

Text Books:

1. Davenport, T. H., & Harris, J. G. (2007). "Competing on analytics: The new science of winning". Harvard Business School Press.
2. Provost, F., & Fawcett, T. (2013). "Data science for business: What you need to know about data mining and data-analytic thinking". O'Reilly Media.
3. Sharda, R., Delen, D., & Turban, E. (2019). "Business intelligence, analytics, and data science: A managerial perspective" (4th ed.). Pearson.
4. Hastie, T., Tibshirani, R., & Friedman, J. (2009). "The elements of statistical learning: Data mining, inference, and prediction" (2nd ed.). Springer.
5. Knaflitz, C. N. (2015). "Storytelling with data: A data visualization guide for business professionals". Wiley.
6. Pearl, J., & Mackenzie, D. (2018). "The book of why: The new science of cause and effect". Basic Books.
7. Lewis, M. (2016). "Marketing data science: Modeling techniques in predictive analytics with R and Python". Pearson FT Press.

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science and CSE (Artificial Intelligence) (2024 Course)		
OEL-221C- AID : Financial Management		
Teaching /scheme	Credits	Examination Scheme
Theory : 02 Hours/Week	02	CCE : 15 Marks End-Semester: 35 Marks

Prerequisite Courses, if any :

1. Programming and Problem Solving

Companion Course if any: NA

Course Objectives: The course aims to:

1. To introduce computer engineering students to the core principles of financial management, emphasizing their relevance in technology companies.
2. To develop students' ability to analyze financial statements, interpret financial data, and evaluate the financial health of organizations.
3. To equip students with the tools and techniques for making sound investment decisions, including project evaluation and risk assessment.
4. To provide an understanding of how financial management principles are applied in the context of engineering projects, software development, and technology ventures.
5. To familiarize students with the ethical, legal, and regulatory considerations that governs financial practices in the technology sector.

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

- CO1- **Demonstrate** a solid **understanding** of fundamental financial management concepts and their application in computer engineering contexts.
- CO2- **Apply** capital budgeting techniques to evaluate the economic viability of technology projects and investments.
- CO3- **Assess** and manage financial risks associated with engineering projects and technology ventures.
- CO4- **Analyze** the role of financial information systems and technologies in supporting financial decision-making.
- CO5- **Apply** ethical and legal principles to financial practices in the computer engineering profession.

Unit I Introduction to Financial Management (07 Hours)

Overview of Financial Management: Goals, principles, and the role of the financial manager in technology organizations.

Forms of Business Organization: Sole proprietorship, partnership, corporation, and their implications for financial decision-making.

Financial Statements Analysis: Balance Sheet: Understanding assets, liabilities, and equity.

Income Statement: Revenue, expenses, and profitability analysis. **Cash Flow Statement:** Sources and uses of cash.

Basic Financial Ratios: Liquidity, profitability, solvency, and efficiency ratios, with a focus on their interpretation in the technology industry.

Case Study: Tesla, Inc. (TESLA) Tesla provides a compelling case study for several reasons: its rapid growth, significant capital investments, innovative products, and at times, volatile financial performance.

Unit II Time Value of Money and Investment Decisions (07 Hours)

Time Value of Money: Present Value and Future Value: Concepts and calculations. Annuities and Perpetuities: Applications in financial planning. Discounting and Compounding: Techniques for evaluating cash flows over time.

Capital Budgeting: Net Present Value (NPV), Calculation, interpretation, and decision rules.

Internal Rate of Return (IRR): Calculation, interpretation, and limitations. **Payback Period:** Calculation, interpretation, and its use in initial screening.

Profitability Index (PI): Calculation, interpretation, and project ranking. **Investment Decisions in IT Projects:** Specific considerations for evaluating software development, infrastructure upgrades, and other technology investments.

Unit III - Financing Decisions and Cost of Capital - (08 Hours)

Sources of Financing: Debt Financing: Types of debt, advantages, and disadvantages. Equity Financing: Types of equity, advantages, and disadvantages.

Hybrid Financing: Convertible securities, preferred stock.

Cost of Capital & Cost of Debt: Calculating the cost of debt, after-tax cost of debt.

Cost of Equity: Methods for estimating the cost of equity (CAPM, DDM).

Weighted Average Cost of Capital (WACC): Calculation and its use in investment decisions.

Capital Structure: Factors affecting capital structure decisions in technology companies. Optimal capital structure: Concepts and considerations.

Leasing: Types of leases (operating vs. financial). Advantages and disadvantages of leasing for technology assets.

Unit IV -Working Capital Management and Financial Planning (08 Hours)

Working Capital Management: Concepts and importance of working capital. Managing current assets (cash, accounts receivable, inventory) in a technology context. Managing current liabilities (accounts payable, short-term debt).

Financial Planning: Short-term financial planning, Cash budgets, pro forma statements. Long-term financial planning: Strategic financial planning for growth and expansion in technology companies.

Financial forecasting: Techniques for predicting future financial needs.

Dividend Policy: Factors affecting dividend decisions in technology firms. Dividend payout ratios and their implications.

Learning Resources

Text Books:

1. Richard Brealey, Stewart Myers, and Franklin Allen, "Principles of Corporate Finance", 14th Edition, McGraw Hill Publication.
2. Stephen Ross, Randolph Westerfield, and Bradford Jordan, "Fundamentals of Corporate Finance" 11th Edition, McGraw Hill Publication
3. Leland Blank and Anthony Tarquin, "Engineering Economy" 8th Edition, McGraw Hill Publication
4. Chan S. Park "Fundamentals of Engineering Economics", Global Edition - 4th Edition, Pearson Education.

Reference Books:

1. David Hillier, Mark Grinblatt, and Sheridan Titman, "Financial Markets and Corporate Strategy", 2nd Edition, McGraw-Hill Education.
2. Project Management: A Managerial Approach by Jack Meredith, Samuel Mantel Jr., and Scott Shafer.

MOOC / NPTEL/YouTube Links: -

1. "Financial Markets" by Robert Shiller (Yale University). A broad introduction to financial markets and their role in the economy. <https://www.coursera.org/learn/financial-markets-global>
2. "Introduction to Corporate Finance" (University of Pennsylvania, Wharton). Covers core corporate finance principles. <https://www.coursera.org/learn/wharton-finance>
3. "Engineering Project Management" (Various Universities). <https://www.coursera.org/specializations/engineering-project-management>
4. "Finance Essentials" (ImperialBusinessX). <https://www.edx.org/search?q=Finance%20Essentials>
5. "Corporate Finance" (IIM Bangalore). <https://www.edx.org/learn/finance/indian-institute-of-management-bangalore-corporate-finance>

Online Links: -

1. Financial Management from an Emerging Market Perspective <https://www.intechopen.com/books/605>
2. Financial News and Data:

- (a) Bloomberg: Provides financial news, data, and analytics.
- (b) Yahoo Finance: Offers stock quotes, financial news, and company information.
- (c) Google Finance: Similar to Yahoo Finance.

3. Professional Organizations:

- (a) Financial Management Association (FMA): Provides resources, publications, and conferences related to financial management.

4. Online Learning Platforms:

- (a) Investopedia: Offers articles, tutorials, and a dictionary of financial terms.
- (b) Corporate Finance Institute (CFI): Offers in-depth online courses and certifications in finance.

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science and CSE (Artificial Intelligence) (2024 Course)		
MDM-231-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 and CSE (Artificial Intelligence) (2024 Course)		
VSE-270-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 <code>ArithmeticException</code>) and invalid input (throwing <code>IllegalArgumentException</code>). 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 <code>NumberFormatException</code> for invalid input and <code>ArithmeticException</code> 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	<p>Inventory managementsystem having the following operations:</p> <ol style="list-style-type: none"> List of all products Display individual product information Purchase Shipping Balance stock Loss and Profit calculation.
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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 Pune University		
Second Year of Artificial Intelligence and Data Science and CSE (Artificial Intelligence) (2024 Course)		
AEC-281- COM: Modern Indian Language (Marathi/Hindi)		
Teaching /scheme	Credits	Examination Scheme
Tutorial : 01 Hour/Week	02	Term Work : 50 Marks
Practical : 02 Hours/Week		

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 & 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 & 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.

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science and CSE (Artificial Intelligence) (2024 Course)		
AEC-281- COM: Modern Indian Language (Hindi)		
Teaching /scheme	Credits	Examination Scheme
Tutorial : 01 Hour/Week Practical : 02 Hours/Week	02	Term Work : 50 Marks

Course Objectives: The course aims to:

उद्देश्य :

- छात्रों में हिंदी भाषा श्रवण कौशल विकसित करना।
- छात्रों में हिंदी भाषा संवाद कौशल विकसित करना।
- छात्रों में हिंदी भाषा वाचन कौशल विकसित करना।
- छात्रों में हिंदी भाषा लेखन कौशल विकसित करना।
- हिंदी भाषा—विधि तथा भाषा—व्यवहार से अवगत करना।

Course Contents

Unit I & II (07 & 08 Hours)

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

Case Study:

Unit III & IV (07 & 08 Hours)

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

Text Books:

संदर्भ ग्रंथ :

१. हिंदी भाषा शिक्षण — संपा. हिंदी अध्ययन मंडल, सावित्रीबाई फुले
पुणे विश्वविद्यालय, पुणे, राजकमल प्रकाशन, नई दिल्ली।
२. हिंदी व्याकरण — पं. कामताप्रसाद गुरु, प्रकाशन संस्थान, नई दिल्ली।
३. प्रयोजनमूलक हिंदी — डॉ. माधव सोनटक्के, लोकभारती प्रकाशन, नई
दिल्ली।

Savitribai Phule Pune University		
Second Year of Artificial Intelligence and Data Science and CSE (Artificial Intelligence) (2024 Course)		
EEM-241-AID- Technology Commercialization and Startup Development		
Teaching /scheme	Credits	Examination Scheme
Practical : 02 Hours/Week	01	Term Work : 25 Marks
Tutorial : 01 Hour/Week	01	

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 Entrepreneurship by prof. Rajat Agrawal, Prof. Vinay Sharma IIT Roorkee.
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 and CSE (Artificial Intelligence) (2024 Course)		
VEC-251- 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>

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