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

Computer Science and Engineering (Data Science)

(With effect from Academic Year 2025-26)

https://www.unipune.ac.in/

Contents

Nomenclature

AEC	Ability Enhancement Course
AICTE	All India Council for Technical Education
AY	Academic Year
CCE	Comprehensive Continuous Evaluation
CEP	Community Engagement Project
ESE	End-Semester Examination
MDM	Multidisciplinary Minor
NEP-2020	National Education Policy - 2020
NPTEL	National Programme on Technology Enhanced Learning
OE	Open Elective
PCC	Program Core Course
PEO	Programme Educational Objectives
PO	Programme Outcomes
PSO	Program Specific Outcomes
SWAYAM	Study Webs of Active-Learning for Young Aspiring Minds
UGC	University Grants Commission
VEC	Value Education Course
VSE	Vocational and Skill Enhancement Course
WK	Knowledge and Attitude Profile

Preface by Board of Studies

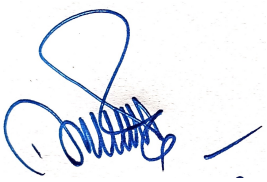
Dear Students and Teachers,

We, the members of Board of Studies Computer Engineering, are very happy to present Second Year Computer Science and Engineering (Data Science) syllabus effective from the Academic Year 2025-26. The present curriculum will be implemented for Second Year of Engineering from the academic year 2025-26. Subsequently this will be carried forward for TE and BE in AY 2026-27, 2027-28, respectively.

This syllabus for the this program in Computer Science and Engineering (Data Science) has been meticulously designed to equip students with a solid foundation in core computer science principles while integrating the interdisciplinary aspects of statistics, machine learning, artificial intelligence, big data analytics, and data visualization. It reflects the dynamic nature of the discipline and aims to bridge the gap between theoretical understanding and practical application.

The revised syllabus falls in line with the objectives of NEP-2020, Savitribai Phule Pune University, AICTE , UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.Wherever possible additional resource links of platforms such as NPTEL, SWAYAM are appropriately provided at the end of each course.This syllabus has been crafted with inputs from academia, industry experts, and evolving global trends to ensure its relevance and impact. It serves as a roadmap for students aspiring to become data scientists, engineers, researchers, and technology leaders, ready to shape the future of digital transformation. It is designed not only to meet the current industry standards but also to prepare students for higher studies and research in the field of computer engineering.

We hope that this curriculum will inspire students to become competent professionals, responsible citizens, and contributors to the technological advancement of society.



Dr. Nilesh Uke
Chairman - Board of Studies
Computer Engineering - SPPU

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Program Specific Outcomes (PSO)

- **PSO1:** Computing and Analytical Proficiency : Graduates will be proficient in designing efficient algorithms, developing intelligent software systems, and utilizing modern computing tools and technologies using Algorithms, System Software, Machine Learning, Artificial Intelligence, Web Applications, Big Data Analytics and Networking for large scale data processing and analytical tasks.
- **PSO2:** Data-Driven Solution Development - Graduates will apply principles of data science, including statistical analysis and machine learning to extract actionable insights and develop innovative solutions for complex engineering and societal challenges.
- **PSO3:** Successful Career and Entrepreneurship- Graduates will exhibit the ability to conduct research, foster innovation, and engage in lifelong learning in data science, contributing to advancements in artificial intelligence, big data, cloud computing, and interdisciplinary fields.

Programme Educational Objectives (PEO)

Program Educational Objectives (PEOs): 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	Attainment of key principles and practices of computation, mathematics and basic principles of engineering to ensure that graduates are able to apply their software development skills in design and implementation of practical systems consisting of software and/or hardware components.
PEO2	Problem solving skills and Ethics	Analyze real-life problems and impart science-based engineering education to develop professional skills that will prepare the students for immediate employment in the industry.
PEO3	Professionalism and Lifelong Learning	Imbibe lifelong learning, professional and ethical attitude for embracing global challenges and make positive impact on environment and society.

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.

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 Computer Science and Engineering (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)

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) :

1. CCE of 30 marks based on all the Units of course syllabus to be scheduled and conducted at institute level.
2. Case studies included under each unit are intended to support applied learning and are part of Comprehensive Continuous Evaluation
3. These case studies will be assessed through internal assessment components such as presentations, assignments, or group discussions. They shall not be included in the End-Semester Theory Examination.
4. To design a Comprehensive Continuous Evaluation scheme for a theory subject of 30 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

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

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

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

Format and Implementation of Comprehensive Continuous Evaluation (CCE)

- **Unit Test**
  - **Format :** Questions designed as per Bloom's Taxonomy guidelines to assess various cognitive levels (Remember, Understand, Apply, Analyze, Evaluate, Create).
  - **Implementation**: Schedule the test after completing Units 1 and 2. Ensure the question paper is balanced and covers key concepts and applications.
- **Sample Question Distribution**
  - Remembering (2 Marks): Define key terms related to [Topic from Units 1 and 2].
  - Understanding (2 Marks): Explain the principle of [Concept] in [Context].
  - Applying (2 Marks): Demonstrate how [Concept] can be used in [Scenario].
  - Analyzing (3 Marks): Compare & contrast [Two related concepts] from Units 1 and 2.
  - Evaluating (3 Marks): Evaluate the effectiveness of [Theory/Model] in [Situation].
- **Assignments / Case Study** : Students should submit one assignment or one Case Study Report based on Unit 3 and one assignment or one Case Study Report based on Unit 4.
  - **Format:** Problem-solving tasks, theoretical questions, practical exercises, or case studies that require in-depth analysis and application of concepts.
  - **Implementation:** Distribute the assignments or case study after covering Units 3 and 4. Provide clear guidelines and a rubric for evaluation.
- **Seminar Presentation:**
  - **Format:** Oral presentation on a topic from Unit 5, followed by a Q&A session.
  - **Deliverables:** Presentation slides, a summary report in 2 to 3 pages, and performance during the presentation.
  - **Implementation:** Schedule the seminar presentations towards the end of the course. Provide students with ample time to prepare and offer guidance on presentation skills.
- **Open Book Test:**
  - **Format:** Analytical and application-based questions to assess depth of understanding.
  - **Implementation:** Schedule the open book test towards the end of the course, ensuring it covers critical aspects of Unit 5.
- **Quiz :**
  - **Format:** Quizzes can help your students practice existing knowledge while stimulating interest in learning about new topic in that course. You can set your quizzes to be completed individually or in small groups.
  - **Implementation:** Online tools and software can be used create quiz. Each quiz is made up of a variety of question types including multiple choice, missing words, true or false etc
- **Example Timeline for conducting CCE:**
  - Weeks 1-4 : Cover Units 1 and 2
  - Week 5 : Conduct Unit Test (12 marks)
  - Weeks 6-8 : Cover Units 3 and 4
  - Week 9 : Distribute and collect Assignments / Case Study (12 marks)
  - Weeks 10-12 : Cover Unit 5
  - Week 13 : Conduct Seminar Presentations or Open Book Test or Quiz (6 marks)
- **Evaluation and Feedback:**
  - **Unit Test:** Evaluate promptly and provide constructive feedback on strengths and areas for improvement.
  - **Assignments / Case Study:** Assess the quality of submissions based on the provided rubric. Offer feedback to help students understand their performance.
  - **Seminar Presentation:** Evaluate based on content, delivery, and engagement during the Q&A session. Provide feedback on presentation skills and comprehension of the topic.

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

End-Semester Examination (ESE)

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

- **Format and Implementation :**
  - **Question Paper Design** : Below structure is to be followed to design an End-Semester Examination (ESE) for a theory subject of 70 marks on all 5 units of the syllabus with questions set as per Bloom's Taxonomy guidelines and 14 marks allocated per unit.
  - **Balanced Coverage**: Ensure balanced coverage of all units with questions that assess different cognitive levels of Bloom's Taxonomy: Remember, Understand, Apply, Analyze, Evaluate, and Create. The questions should be structured to cover:
    - Remembering: Basic recall of facts and concepts.
    - Understanding: Explanation of ideas or concepts.
    - Applying: Use of information in new situations.
    - Analyzing: Drawing connections among ideas.
    - Evaluating: Justifying a decision or course of action.
    - Creating: Producing new or original work (if applicable).
  - **Detailed Scheme for 70 Marks :** Unit-Wise Allocation (14 Marks per Unit): Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.
  - **Detailed Scheme for 35 Marks :** Unit-Wise Allocation (08 Marks for Unit 1 , 09 Marks for Unit 2, Unit 3 and Unit 4) : Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.

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

Level 5.0

Course Code	Course Type	Course Name	Teaching Scheme			Examination Scheme						Credits			
			Theory	Tutorial	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Tutorial	Practical	Total
PCC-201-CDS	Program Core Course	Data Structures and Algorithms	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-202-CDS	Program Core Course	Computer Graphics	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-203-CDS	Program Core Course	Data Storytelling and Visualization	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-205-CDS	Program Core Course	Data Structures and Algorithms Laboratory	-	-	4	-	-	25	50	-	75	-	-	2	2
PCC-206- CDS	Program Core Courses	Computer Graphics Laboratory	-	-	2	-	-	-	-	50	50	-	-	1	1
	Open Elective	Open Elective I	2	-	-	15	35	-	-	-	50	2	-	-	2
MDM-221-CDS	Multi disciplinary Minor	Digital Electronics and Logic Design	2	-	-	30	70	-	-	-	100	2	-	-	2
EEM-231- CDS	Entrepreneurship Management	Entrepreneurship Development	-	1	2	-	-	25	-	-	25	-	1	1	2
VEC-232- CDS	Value Education Course	Universal Human Values and Professional Ethics	2	-	-	15	35	-	-	-	50	2	-	-	2
CEF-241- CDS	Community Engagement Project	Community Engagement Project	-	-	4	-	-	25	-	25	50	-	-	2	2
Total			**15**	**01**	**12**	**150**	**350**	**75**	**50**	**75**	**700**	**15**	**01**	**06**	**22**

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

- Example – Open Elective I - Financial Accounting, Digital Finance, Digital Marketing can be opted from Commerce and Management faculty.
- Elective II - Project Management, Business Analytics, Financial Management can be opted from Inter-Disciplinary studies, Commerce and Management faculty respectively.

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

Level 5.0

Course Code	Course Type	Course Name	Teaching Scheme			Examination Scheme						Credits			
			Theory	Tutorial	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Tutorial	Practical	Total
PCC-251-CDS	Program Core Course	Database Management systems	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-252- CDS	Program Core Course	System Programming and Operating System	2	-	-	30	70	-	-	-	100	2	-	-	2
PCC-253- CDS	Program Core Course	Mathematical Foundation for Data Science	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-254- CDS	Program Core Course	Database Management systems Laboratory	-	-	2	-	-	25	25	-	50	-	-	1	1
PCC-255- CDS	Program Core Course	System Programming and Operating System Laboratory	-	-	2	-	-	-	-	25	25			1	1
	Open Elective	Open Elective II	2	-	-	15	35	-	-	-	50	2	-	-	2
MDM-271-CDS	Multi Disciplinary Minor	Internet Internet of Things	2	-	-	30	70	-	-	-	100	2	-	-	2
VSE- 281-CDS	Vocational and Skill Enhancement Course	Object Oriented Programming (Java)	-	-	4	-	-	25	25	-	50	-	-	2	2
AEC-282- CDS	Ability Enhancement Course	Modern Indian Language (Marathi)	-	1	2	-	-	50	-	-	50	-	1	1	2
EEM-283-CDS	Entrepreneurship /Economics / Management	Technology Commercialization and Startup	-	1	2	-	-	25			25		1	1	2
VEC-284- CDS	Value Education Course	Environmental Studies	2	-	-	15	35	-	-		50	-	-	2	2
Total			**14**	2	**12**	**150**	**350**	**125**	**50**	**25**	**700**	**12**	**2**	**8**	**22**

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

- Example – Open Elective I - Financial Accounting, Digital Finance, Digital Marketing can be opted from Commerce and Management faculty.
- Elective II - Project Management, Business Analytics, Financial Management can be opted from Inter-Disciplinary studies, Commerce and Management faculty respectively.

Savitribai Phule Pune University, Pune

Maharashtra, India

SE - Computer Science and Engineering (Data Science)

2024 Pattern

Semester III

With effect from Academic Year 2025-26

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science)(2024 Course)		
PCC-201- CDS: Data Structures and Algorithms		
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 : Data Structure and Algorithm Laboratory

Course Objectives: The course aims to:

1. To understand the standard and abstract data representation methods.
2. To acquaint with the structural constraints and advantages in usage of data.
3. To understand various data structures, operations on it and the memory requirements
4. To understand various data searching and sorting methods.
5. To understand various algorithmic strategies to approach the problem solution.

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

- CO1: **Design** the algorithms to solve the programming problems, identify appropriate algorithmic strategy for specific application, and analyze the time and space complexity.
- CO2: **Understand** the computational efficiency of the principal algorithms for searching and sorting and choose the most efficient one for the application.
- CO3: **Implement and Apply** principles of data structures-stack and queue to solve computational problems.
- CO4: Students will be able to **choose** appropriate data structure and apply it to solve problems in various domains tree and graphs.
- CO5: Students will be able to **demonstrate** the ability of stack and queue & its operations.
- CO6: Students will be able to **choose** an appropriate data structure and apply it to solve problems in various domains hashing and files.

Course Contents

Unit I - Introduction to Data Structures & Algorithms (09 Hours)

Introduction: Introduction to data, Difference between Data and Information, need of Data structure, Definition of Data Structure, ADT, Types of Data Structure.
Algorithms: Frequency count and its importance in analysis of an algorithm, Time complexity & Space complexity of an algorithm Big 'O', 'Ω' and 'Θ' notations.
Algorithmic Strategies: Introduction to algorithm design strategies- Divide and Conquer, and Greedy strategy. Sequential Organization: Single and multidimensional array and address calculation, Sparse matrix representation using array.
Linked Organization: Introduction to linked organization, Singly Linked List, Doubly Linked List,
Circular Linked List. Linked Organization: Concept of linked organization, Singly Linked List, Doubly Linked List, Circular Linked List (Operations: Create, Display, Search, Insert, Delete)

Case Study: Study use of sparse matrix in Social Networks and Maps. Study how Economists use polynomials to model economic growth patterns, how medical researchers use them to describe the
behavior of Covid-19 virus

Unit II - Searching and Sorting (09 Hours)

Searching: Introduction to Searching, Search Technique- Sequential Search, Sentinel Search, Binary Search,Fibonacci Search, and Indexed Sequential Search.

Sorting: Introduction to Sorting, Sort Concepts-Sort Order, Stability, Efficiency, and Number of Passes, Comparison Based Sorting Methods-Bubble Sort, Insertion Sort, Selection Sort, Quick Sort, Shell Sort, Non- comparison Based

Sorting Methods- Radix Sort, Counting Sort, and Bucket Sort, Comparison of All Sorting Methods and their complexities.

Case Study : Use of Fibonacci search in non-uniform access memory storage and in Optimization of Unimodal Functions. Timesort as a hybrid stable sorting algorithm.

Unit III - Stack & Queue (09 Hours)

Stack: Concept of stack, Concept of implicit and explicit stack, stack as an ADT using sequential and linked organization, Applications of stack: recursion, converting expressions from infix to postfix or prefix form, evaluating postfix or prefix form.

Queue: Concept of queues as ADT, Implementation of queue using array and linked organization, Concept of circular queue, double ended queue, Applications of queue: priority

Case study: Reversing a string, balanced parentheses in algebraic expressions, Towers of Hanoi problem, double ended queue as Stack and Queue

Unit IV - Trees and Graph (09 Hours)

Tree- Basic terminology, General tree and its representation, Binary tree- properties, converting tree to binary tree, binary tree traversals (recursive and non-recursive)- Inorder, preorder, post order, depth first and breadth first, Operations on binary tree, Binary Search Tree (BST), BST operations, threaded binary search treeconcepts, threading, insertion and deletion of nodes in inorder threaded binary search tree, in order traversal of in-order threaded binary search tree.

Graph - Basic Concepts, Storage representation, Adjacency matrix, adjacency list, adjacency multi list, inverse adjacency list. Traversals-depth first and breadth first, Minimum spanning Tree, Greedy algorithms for computing minimum spanning tree-Prims and Kruskal Algorithms, Dijkstra's Single source shortest path, All pairs shortest pathsFlyod-Warshall Algorithm Topological ordering.

Case study : Use of binary tree in expression tree-evaluation and Huffman's coding, Data structure used in Web graph and Google map

Unit V - Hashing and Indexing (09 Hours)

Hashing: Introduction to hash tables, basic concepts, hash function, characteristics of a good hash function, key-to-address transformation techniques, synonyms or collisions, collision resolution techniques: linear probing, quadratic probing, rehashing, chaining with and without replacement.

File: Introduction to files, file types and file organization, sequential access, index sequential access, direct access, comparison of different file organizations.

Case study: What are the advantages of binary tree and binary search in Files.

Learning Resources

Text Books:

1. Y. Langsam, M. Augenstin, A. Tannenbaum, "Data Structures using C and C++", 2nd Edition, Prentice Hall of India, 2002, ISBN-81-203-1177-9.
2. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Data Structures and Algorithms in Python, Wiley Publication, ISBN: 978-1-118-29027-9

Reference Books:

1. Aho, J. Hopcroft, J. Ulman, Data Structures and Algorithms, Pearson Education, 1998, ISBN-0-201-43578-0.
2. Michael J Folk, File Structures an Object-Oriented Approach with C++||, Pearson Education, ISBN: 81-7758-373-5.
3. A. Tharp, "File Organization and Processing", 2008, Willey India edition, 9788126518685
4. M. Weis M. Weiss—Data Structures and Algorithm Analysis in C++, 2nd edition, Pearson Education, 2002, ISBN-81-7808-670-0.

MOOC / NPTEL/YouTube Links: -

1. Programming, Data Structures And Algorithms Using Python By Prof. Madhavan Mukund https://onlinecourses.nptel.ac.in/r
2. Introduction to Data Structures and Algorithms https://nptel.ac.in/courses/106102064

YouTube/Video Links:

1. https://www.youtube.com/playlist?list=PLeo1K3hjS3uu_n_a__MI_KktGTLYopZ12

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2024 Course)		
PCC -202- CDS: Computer Graphics		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 30 Marks **End-Semester**: 70 Marks

Prerequisite Courses, : Basic Mathematics

Companion Course : Computer Graphics Laboratory

Course Objectives: The course aims to:

1. To understand the fundamental concepts of computer graphics, including graphics primitives, display devices, and scan conversion algorithms.
2. To explore polygon representations, clipping algorithms, and windowing techniques for effective rendering.
3. To study 2D and 3D geometric transformations, including translation, scaling, rotation, and projection techniques.
4. To introduce curves, fractals, and animation principles for creating dynamic visual content.
5. To gain hands-on experience with OpenGL and Unity for implementing interactive graphics applications

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

- CO1: **Explain** basic computer graphics concepts, display devices, and algorithms for line and circle drawing.
- CO2: **Gain** an understanding of geometric, mathematical, and algorithmic concepts essential for programming computer graphics.
- CO3: **Apply** polygon filling, clipping techniques, and viewing transformations for rendering objects.
- CO4: **Implement** 2D and 3D transformations for object manipulation and projection in graphical applications.
- CO5: **Develop** interactive graphics using curves, fractals, and animation techniques. CO6: Utilize OpenGL and Unity for graphics programming and real-time rendering

Course Contents

Unit I - Introduction and Overview of Graphics System (09 Hours)

Introduction to computer graphics primitives: Pixel, Resolution, Aspect ratio, Frame buffer, Applications of computer graphics, Random scan display, Raster scan display.

Display Devices: OLED, Micro-OLED, Active Matrix OLED (AMOLED), Quantum Dot (QLED) Scan conversion: Line drawing algorithms: Digital Differential Analyzer (DDA), Bresenham Circle drawing algorithms: DDA, Bresenham, and Midpoint. Introduction to aliasing and anti-aliasing.

Case Study: Use of DDA Algorithm in Robotics and Path Planning.

Unit II - Polygons and Clipping (09 Hours)

Polygons: Representation of polygon and its types: convex, concave and complex, Inside Test Polygon filling methods: Seed Fill – Flood fill and Boundary Fill, Scan-line Fill algorithms Windowing: Concept of window and viewport, viewing transformations

Clipping: Point clipping, Cohen Sutherland line clipping algorithm, Sutherland Hodgeman polygon clipping algorithm, Weiler Atherton polygon clipping algorithm.

Case Study: Study Guard clipping Techniques and its use in various rendering softwares, use 3D polygonal modelling and applications.

Unit III - Geometric Transformations (09 Hours)

2D Transformations: Translation, Rotation, Scaling, Mirroring and Shearing, Homogeneous coordinate system, Composite transformations, Rotation about an arbitrary point.

3D Transformation: Translation, Scaling, Rotation about X, Y, Z & arbitrary axis reflection about XY, YZ, XZ plane. Projection: Parallel and Perspective Projections.

Case Study: Study the use of 3D Geometric Transformations in Gaming.

Unit IV - Curves, Fractals and Animation (09 Hours)

Curves: Introduction, Bezier curves, B-Splines

Fractals: Introduction, Classification, Fractal Dimension, Fractal surfaces, Hilbert curve, Koch Curve
Animation: Basics of animation, types of animation, principles of animation
Animation Tool: Introduction to Blender, design of animation sequences, key frame, morphing, motion specification. Methods of controlling animation, frame-by-frame animation techniques.

Case Study: Designing a Smooth Car Path using Bezier and B-Spline curves.

Unit V - Graphics and Interactive Systems Development with OpenGL and Unity (09 Hours)

OpenGL: Introduction Graphics function, OpenGL Interface, primitives and attributes, Control functions, programming events.

Introducing Unity : Game Engine Concept, Unity Development Environment, Introduction to Scripting, am Simple Movement and Input, Simple Rotation and Scaling, Creating and Destroying Objects, Introduction to AR And VR, Publishing Games.

Case Study : Design Simple 2D Platformer Game in Unity.

Learning Resources

- **Text Books:**

1. S. Harrington, Computer Graphics, 2nd Edition, McGraw-Hill Publications, 1987. ISBN: 0-07-100472-6.
2. Buckley, Ed., Organic Light-Emitting Diodes (OLEDs): Materials, Devices and Applications. Cambridge, UK: Woodhead Publishing, 2013
3. Computer Graphics, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 1997.
4. A. Brito, Blender 4.0: The Beginner's Guide. Birmingham, UK: Packt Publishing, 2024, ISBN 978-1804612099.
5. Donald D. Hearn and M. Pauline Baker, Computer Graphics with OpenGL, 4th Edition, Pearson, ISBN13: 978-0136053583.
6. John Kessenich, Graham Sellers, and Dave Shreiner, OpenGL Programming Guide (Red Book).
7. "Unity 2020 Virtual Reality Projects - Third Edition" by Jonathan Linowes , Packt Publishing, ISBN-13: 978-1839217330.

- **Reference Books:**

- D. Rogers, Procedural Elements for Computer Graphics, 2nd ed. New Delhi, India: Tata McGraw-Hill, 2001, ISBN 0-07-047371-4.
- J. Foley, A. van Dam, S. Feiner, and J. Hughes, Computer Graphics: Principles and Practice, 2nd ed. Boston, MA, USA: Pearson Education, 2003, ISBN 81-7808-038-9.
- F. S. Hill Jr., Computer Graphics Using OpenGL. Boston, MA, USA: Pearson Education
- D. D. Hearn and M. P. Baker, Computer Graphics: C Version. New Delhi, India: Pearson Education India,2009.
- J. G. Bond, Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#, 3rd ed. Boston, MA, USA: Addison-Wesley Professional, 2022.

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

1. https://onlinecourses.nptel.ac.in/noc20_cs90/preview
2. https://archive.nptel.ac.in/courses/106/106/106106090

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2024 Course)		
PCC-203-CDS: Data Storytelling and Visualization		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 30 Marks **End-Semester:** 70 Marks

Prerequisite Courses : Basic Data Literacy, Familiarity with charts, AEC-101Professional Communication Skills
Course Objectives: The course aims to:

1. To enable the students to get acquainted with the context of the data.
2. To learn various approaches to gain data insights.
3. To enable the transformation of insights to the story and its presentation.
4. To learn various tools and techniques of data visualization.
5. To understand components of data visualization.

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

- CO1: **Understand** the data analysis with context of the data.
- CO2: **Explore** and create insights for the target audience.
- CO3: **Summarize** the metrics towards desired performance.
- CO4: **Design and develop** data visualizations.
- CO5: **Apply** data visualization techniques in various domains.
- CO6: **Apply** Design Thinking techniques to solution choices

Course Contents

Unit I - Introduction to data storytelling (06 Hours)

Need of storytelling, the psychology and anatomy of storytelling, how data is communicated, understanding the target audience, impact of storytelling, exploring and discovering data, ethics in data storytelling, case studies- Industry-specific Data Stories- Healthcare, finance, marketing, E-commerce, Science, Social Media,

Case Study:

1. Discussion on Public opinion shaping in politics, Urban planning, and transportation.
2. Understanding Urban Mobility Patterns: A Data Storytelling Challenge

Unit II - Designing and delivering the storyline (06 Hours)

Capturing the insights, valuable insights, focus of data points, evaluation of the data for better insights, defining the structure of the storyline, creation of the storyline for analysis, Format of the story, determining best visualization, selection of appropriate design, Ways of delivering the storyline, the narration, visuals: setting the scenes, polishing the scenes, Challenges and opportunities in different industries for Data Storytelling

Case Study :

1. Discussion on Social media sentiment analysis, Geographic data visualization for disaster response.
2. Designing and Delivering the Storyline for Reducing Energy Consumption .

Unit III - Foundations of Data Visualization (06Hours)

Data Pre-processing, Overview of Data Visualization, Need of data visualization, The Human Brain and Data Visualization, The Shapes of Data, Inputs for data visualization, Types of Visualizations: Cognitive vs Perceptual. Design Distinction, Examples of the Types of Visualizations, 5 big data visualization categories: temporal, hierarchical, network, multidimensional and geospatial, Practicing Good Ethics in Data Visualization, Ineffective Visuals and How to Improve Them, Principles of Visual Perception, Color as a Pre-Attentive Attribute, Strategic Use of Contrast, Tools for Visualizing: PowerBI, Tableau etc., Real-world Data Visualization Projects-Success stories, Innovations and trends in data visualization using different tools, case study.

Case study:

1. Discussion on Customer churn prediction in telecommunications, Financial market dashboard analysis, Public health communication during pandemics.
2. Building a Clear COVID-19 Data Dashboard: Applying the Foundations of Data Visualization.

Unit IV - Best Practices of Data Visualization (06 Hours)

Gestalt Principle: Proximity, Accessible Visualizations, Aesthetic, Design and Exploratory Analysis Introduction, Exploratory and Explanatory Analysis, Data, Relationships and Design Static Versus Interactive Visualizations, Bringing everything together in a dashboard, Moving from Foundational to Advanced Visualizations: Bar charts, Gantt charts, Stacked bars, Tree maps, Area charts, Pie charts; Visualizing distributions: Circle charts, Jittering, Box and whisker plots, Histograms, Future Trends in Data Storytelling & Visualization

Case study :

1. Discussion on Social network analysis, Customer segmentation in e- commerce, Project management dashboard.
2. Redesigning Hospital Performance Dashboards Using Best Practices in Data Visualization

Unit V - Advanced Visualization Techniques (06 Hours)

Geospatial Visualization Mapping data- Using GIS tools and libraries, Network and Graph Visualization, Visualizing relationships and connections- Node-link diagrams, matrix plots etc., Temporal Visualization,
Time-series analysis and visualization, Animation and dynamic visualizations, Hierarchical and Tree Visualization Tree maps, dendrograms, etc. Representing hierarchical structures- Multidimensional Visualization, Parallel coordinates, radar charts, etc. Visualizing high-dimensional data- Text and Sentiment Visualization, Word clouds, sentiment analysis, visualizing textual data- Dashboard Design and Development, designing interactive dashboards, User experience and usability considerations, Emerging Technologies in Data Visualization- Virtual reality, augmented reality, AI and machine learning in visualization.

Case study:

1. Environmental monitoring and conservation, Epidemiological analysis and disease surveillance.
2. Visualizing Climate Change Patterns Using Advanced Techniques.

Learning Resources

Text Books:

1. Storytelling with data, cole nussbaumer knaflic, Wiley.
2. Fundamentals of Data Visualization by Claus O. Wilke, April 2019, O'Reilly Media, Inc., ISBN: 9781492031086
3. Communicating Data with Tableau: Designing, Developing, and Delivering Data Visualizations, Ben Jones.

Reference Books:

1. Effective Data Storytelling: How to Drive Change with Data, Narrative and Visuals, Brent Dykes,
2. Wiley Data Story: Explain Data and Inspire Action Through Story, Nancy Duarte
3. The Big Book of Dashboards, Steve Wexler, Jeffrey Haffer, Andy Cotgreave
4. Practical Tableau, Ryan Sleeper
5. https://www.tableau.com/learn/articles/interactive-map-and-data-visualizationexamples
6. https://www.analyticsvidhya.com/blog/2017/07/data-visualisation-made-easy/
7. https://rafalab.github.io/dsbook/ggplot2.html#aesthetic-mappings

e-Books

1. https://www.elsevier.com/books/systems-programming/anthony/978-0-12-800729-7
2. https://www.kobo.com/us/en/ebook/linux-system-programming-1
3. https://www.ebooks.com/en-us/subjects/computers-operating-systems-ebooks/279/
4. https://www.e-booksdirectory.com/details.php?ebook=9907

MOOC / NPTEL/YouTube Links: -

1. https://www.udacity.com/course/introduction-to-operating-systems--ud923
2. Nptel video lecture link: https://nptel.ac.in/courses/106/105/106105214/
3. https://www.edx.org/course/computer-hardware-and-operating-systems
4. https://onlinecourses.nptel.ac.in/noc19_cs50/preview
5. https://www.udemy.com/course/system-programming/

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2024 Course)		
PCC-205 CDS: Data Structures and Algorithms Laboratory		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 04 Hours/Week	02	**Term Work** : 25 Marks **Practical :** 50 Marks

Prerequisite Courses : Basics of python programming and Principles of Problem Solving
Companion Course : Data Structures
Course Objectives: The course aims to:

1. To understand practical implementation and usage of nonlinear 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: **Understand** the ADT/libraries, hash tables and dictionary to design algorithms for a specific problem.
- CO2: Choose most appropriate data structures and **apply** algorithms for graphical solutions of the problems.
- CO3: **Apply** and analyze nonlinear data structures to solve real world complex problems.
- CO4:Apply and **analyze** algorithm design techniques for indexing, sorting, multi-way searching, file organization and compression.
- 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 list is provided in groups- A, B, C, D, E. Each student must perform at least 12 assignments (at least 03 from group A, 03 from group B, 02 from group C, 2 from group D, 02 from group E)

Operating System recommended: - 64-bit Open-source Linux or its derivative

Programming tools recommended: - Open-Source Python, C++ Programming tool like G++/GCC

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

Sr.	Group A
1	In the first year, Computer Science and Engineering in Data Science class, students are grouped based on the extracurricular activities they participate in. • Group X students participate in robotics club • Group Y students participate in drama club • Group Z students participate in music club Write a Python or C++ program using functions to compute the following: a) List of students who participate in both robotics and drama b) List of students who participate in either robotics or drama but not both c) Number of students who participate in neither robotics nor drama d) Number of students who participate in robotics and music but not drama
2	Write a Python or C++ program to store the number of books read by each student in a month by N students in a literature club. Write functions to compute the following: a) The average number of books read by the students b) The maximum and minimum number of books read c) Count of students who did not read any book (assume 0 books means didn't read) d) Display the number of books read with highest frequency (i.e., most common number)
3	The parking management system of a multi-storey parking lot needs to be implemented using a Python or C++ program. There are 5 floors, and each floor has 15 parking spots. A doubly circular linked list must be maintained to keep track of free parking spots on each floor. Use an array to store head pointers to the linked list of each floor. Assume some random vehicles are parked initially. Write a program to perform the following: a) Display the list of available parking spots on all floors b) Park a vehicle in a selected floor and spot c) Vacate a parking spot (vehicle exit)
4	In the first year, Computer Science and Engineering in Data Science class, • Set X of students prefer online lectures • Set Y of students prefer offline lectures Write a Python or C++ program to store these two sets using linked lists, and compute and display: a) Set of students who prefer both online and offline lectures b) Set of students who prefer either online or offline lectures but not both c) Number of students who prefer neither online nor offline lectures (i.e., have no preference or didn't respond)
5	Write a Python or C++ program to store a hexadecimal number using a doubly linked list. Write functions to perform the following operations: a) Compute the 1's and 2's complement of the hexadecimal number b) Add two hexadecimal numbers stored using doubly linked lists
	Group B
1	Write a Python or C++ program to store the book titles and their authors in sorted order based on book titles. Implement both recursive and non-recursive binary search to search for a book by its title. If the book is not present in the list, insert it into the collection.
2	Write a Python or C++ program to store book titles and their authors in sorted order on book titles. Use Fibonacci search to search for a book. If the book is not found, insert the new book and author into the list. a) Selection Sort. b) Bubble Sort and display the top five highest sales
3	Write a Python or C++ program to store the monthly expenses of employees in an array. Write functions to sort the array of floating-point expenses in ascending order using: a) Insertion Sort. b) Shell Sort and display the top five highest expenses.

4	Write a Python or C++ program to store the annual salary of employees in an array. Write a function to sort the array of floating-point salary values in ascending order using: Quick Sort, and display the top five highest salaries.
5	Write a Python or C++ program to store the ratings (out of 10) of movies watched by users in an array. Write a function to sort the array of floating-point ratings in ascending order using: Bucket Sort, and display the top five highest ratings.
	Group C
1	Write a Python or C++ program to check if a given sentence is a palindrome, where the characters are case-insensitive and spaces are ignored. Write functions to: a) Print the original sentence followed by its reversed version using a stack. b) Check whether the given sentence is a palindrome or not. For example, "A man a plan a canal Panama" is a palindrome when spaces and capitalization are ignored.
2	Write a Python or C++ program to check if a mathematical expression (which may contain parentheses (), curly braces {}, and square brackets []) is well-balanced (i.e., properly matched and closed). Write a function that uses a stack to check whether the given expression is well-balanced, meaning each opening delimiter has a corresponding closing delimiter in the correct order. For example: The expression "(a + b) * [c + {d / e}]" is well-balanced. The expression "(a + b] * {c + d})" is not well-balanced.
3	Write a Python or C++ program to simulate a task queue for a printing system. Each task in the queue represents a document to be printed. The tasks are processed in the order they arrive (i.e., in a first-in-first-out (FIFO) manner). Write functions to: 1. Add an element at the front of the deque. 2. Add an element at the rear of the deque. 3. Delete an element from the front of the deque. 4. Delete an element from the rear of the deque. Display the current elements in the deque
4	Write a Python or C++ program to simulate a pizza parlor that accepts a maximum of M orders. Orders are accepted on a first-come, first-served basis, and once placed, an order cannot be cancelled. The system should use a circular queue to manage the orders. The program should include the following functionalities: 1. Place an order: Add an order to the queue if space is available. 2. Serve an order: Process and remove the first order in the queue. 3. Display the current orders: Show all the pending orders in the queue.
5	Write a Python or C++ program to simulate a double-ended queue (deque) using a one dimensional array. A deque allows elements to be added or removed from both ends of the queue. Write functions to: 1. Add an element at the front of the deque. 2. Add an element at the rear of the deque. 3. Delete an element from the front of the deque. 4. Delete an element from the rear of the deque. Display the current elements in the deque
6	Write a C++ program to implement a priority queue using an inorder list to store the items in the queue. Create a class that includes: A template data type for the items stored in the queue. An integer priority (for sorting by priority). An overloaded <= operator to compare the priority of two items, ensuring that items with higher priority appear earlier in the list. Use an inorder list to maintain the elements in sorted order.
	Group D
1	A company consists of departments, each department consists of teams, and each team consists of employees. Construct a tree to represent this organizational structure and print the nodes. Also, find the time and space requirements of your method.

2	Start with an empty Binary Search Tree (BST) and insert the values in the given order. After building the tree, perform the following tasks: 1. Insert a new node with a given value. 2. Find the number of leaf nodes (nodes with no children). 3. Find the maximum value in the tree. 4. Mirror the tree (swap left and right children at every node). Delete a given node and adjust the tree accordingly
3	Design a Dictionary using a Binary Search Tree (BST) to store keywords and their meanings. Implement the following functionalities: 1. Add a new keyword with its meaning to the dictionary. 2. Delete a keyword from the dictionary. 3. Update the meaning of an existing keyword. 4. Display all keywords and their meanings sorted in ascending or descending order. 5. Find the maximum number of comparisons required to search for a keyword in the tree.
4	A tour operator arranges guided train journeys across Punjab. Passengers may have different travel preferences. The operator offers multiple train routes between cities. Every day, the train departs from a starting city S and travels to a destination city F, as selected by the passenger. During the journey, passengers can enjoy the scenic views along the route. The passengers can choose their preferred routes based on the available options. However, there are restrictions on the routes that the passengers can choose: 1. The train must follow the shortest route from city S to city F. 2. Alternatively, the train may follow a route that is one distance unit longer than the shortest route. Two routes from S to F are considered different if there is at least one track (railway line) between cities A and B that is part of one route but not in the other. You are required to: 1. Represent the graph using either an adjacency list or an adjacency matrix. 2. Check if the graph is connected (i.e., if there is a path between every pair of stations). 3. Justify the storage representation used (adjacency list or adjacency matrix).
5	You manage warehouses in different cities and need to establish communication links between them. The cost of connecting each pair of cities varies. Your goal is to minimize the total cost of connecting all warehouses, ensuring each warehouse can communicate with every other warehouse, either directly or indirectly.
Group E	
1	You are managing a database of employee IDs and their corresponding details (such as name and department). To efficiently search for employee details, you decide to use a hash table. Your task is to implement two different collision handling techniques and compare their performance by counting the number of comparisons required to retrieve employee details for a set of employee IDs.
2	You need to implement a student records system using a hash table. Each student has a unique ID (key) and associated details (value). The system should support the following operations: Insert (key, value): Add a new student record. Find (key): Retrieve student details by ID. Delete (key): Remove a student record by ID. Handle collisions using chaining and allow replacement if a student with the same ID is inserted again.
3	The library system maintains a record of books. The file contains book ID, title, author, and genre. Allow the user to add, delete, or view information about a particular book. If a book record does not exist, display an appropriate message. If it exists, display the book details. Use a sequential file to store the data.
4	The company system manages employee records with details like employee ID, name, designation, and salary. Users can add, delete, or view an employee's information. If the employee does not exist, display an appropriate message; if found, show the employee's details. Use index sequential files to store and manage the data.

5	Implement a student management system using a direct access file. The system should support the insertion and deletion of student records, where each record contains student ID, name, and grade. The records should be stored in a way that allows direct access based on student ID. The system should allow users to insert new student records, delete existing records, and handle appropriate updates to the file.

Learning Resources

Text Books

1. Data structures and algorithms in python by Michael T. Goodrich, ISBN-13: 978- 1118290279, ISBN-10: 1118290275, Publisher: Wiley; 1st edition (March 18, 2013).
2. Problem Solving with Algorithms and Data Structures Using Python by Bradley N Miller and David L. Ranum. ISBN-13: 978-1590282571, ISBN-10: 1590282574, Publisher: Franklin, Beedle & Associates; 2nd edition (August 22, 2011).

Reference Books

1. Hands-On Data Structures and Algorithms with Python: Write complex and powerful code using the latest features of Python 3.7, 2nd Edition by Dr. Basant Agarwal, Benjamin Baka. ISBN: 9781788991933, 2018.
2. Core Python Programming -R. Nageswara Rao, ISBN-10: 9789351199427, ISBN-13: 978- 9351199427, Willy; 1st edition (January 1, 2016).

MOOC/NPTEL/SWAYAM Course Links:

1. NPTEL :- Programming, Data Structures and Algorithms using Python By Prof. Madhavan Mukund, Chennai Mathematical Institute, https://archive.nptel.ac.in/courses/106/106/106106145/

YouTube/Video Links:

1. https://www.youtube.com/playlist?list=PLeo1K3hjS3uu_n_a__MI_KktGTLYopZ12

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2024 Course)		
PCC-206 CDS: Computer Graphics Laboratory		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	02	**Oral :** 50 Marks

Prerequisite Courses :Basic Geometry, Trigonometry, Vectors and Matrices
Companion Course : PCC-202-CDS: Computer Graphics
Course Objectives: The course aims to:

1. Remembering: To introduce learners to the fundamental principles of Computer Graphics.
2. Understanding: To study different algorithms used for creating and rendering graphical elements.
3. Applying: To understand the mathematical concepts involved in graphical transformations.
4. Creating: To develop interactive graphics applications using OpenGL.

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

- CO1: **Understand and define** key terms in Computer Graphics, grasp the mathematical foundations behind graphical concepts, and utilize them to write basic graphics-related programs.
- CO2: **Explain** the principles of windowing and clipping, and implement algorithms for polygon filling and clipping.
- CO3: **Describe** essential concepts such as 2D and 3D transformations, viewing techniques, and projection methods.
- CO4: **Design and implement** interactive visual elements using curves, fractal patterns, and animation methods.
- CO5: **Apply** OpenGL tools for graphics development and real-time visual rendering

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.

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Continuous assessment of laboratory work should be done based on overall performance and Laboratory assignments performance of student. Each Laboratory assignment assessment should be assigned grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each Laboratory assignment assessment include timely completion performance, innovation, efficient codes, punctuality and neatness.

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

Operating System recommended :-

64-bit Open source Linux or its derivative Programming tools recommended: - Open Source C++ Programming tool like G++/GCC, OPENGL.

Guidelines for Oral Examination

Suggested List of Laboratory Experiments/Assignments

Sr.	Group A: Arrays and Searching Sorting Algorithms
1	a) Write a C++ program to control a ball using arrow keys. OR b) Write a C++ program to implement a bouncing ball using sine wave form. OR c) Write C++ program to draw a man walking in the rain with an umbrella. OR d) Write a C++ program to implement the game of 8 puzzles. OR e) Write a C++ program to implement the game Tic Tac Toe.
2	Write C++ program for line drawing using DDA or Bresenhams algorithm with patterns such as solid, dotted, dashed, dash dot and thick.
3	Write C++ program to draw a concave polygon and fill it with desired color using scan fill algorithm.
4	Write C++ program to implement Cohen-Sutherland line clipping algorithm for a given window.
5	Write C++ program to implement Cohen Sutherland Hodgman algorithm to clip any given polygon.
6	Write C++ program to draw 2-D objects and perform the following basic transformations, scaling, rotation, scaling.
7	Write C++ program to draw any object such as flower, waves using Bezier Curve generation technique.
8	Write an OpenGL program to generate fractal patterns by using Koch curves.
	MINI PROJECT
1	Design and implement Game/ Animation Clip/ Graphics Editor/ Mobile App etc. using Blender/Maya/ OpenGL/Unity Software etc.

Learning Resources

Text Books

1. Donald D. Hearn and M. Pauline Baker, Computer Graphics with OpenGL, 4th Edition, Pearson, ISBN-13: 978-0136053583.
2. John Kessenich, Graham Sellers, and Dave Shreiner, OpenGL Programming Guide (Red Book). "Unity 2020 Virtual Reality Projects - Third Edition" by Jonathan Linowes , Packt Publishing, ISBN.
3. Unity 2020 Virtual Reality Projects - Third Edition by Jonathan Linowes , Packt Publishing, ISBN 13: 978-1839217330

Reference Books

1. D. Rogers, Procedural Elements for Computer Graphics, 2nd ed. New Delhi, India: Tata McGraw Hill, 2001, ISBN 0-07-047371-4.
2. J. Foley, A. van Dam, S. Feiner, and J. Hughes, Computer Graphics: Principles and Practice, 2nd ed. Boston, MA, USA: Pearson Education, 2003, ISBN 81-7808-038-9.
3. F. S. Hill Jr., Computer Graphics Using OpenGL. Boston, MA, USA: Pearson Education
4. D. D. Hearn and M. P. Baker, Computer Graphics: C Version. New Delhi, India: Pearson Education India,2009.
5. J. G. Bond, Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#, 3rd ed. Boston, MA, USA: Addison-Wesley Professional, 2022.

Additional Resources: (e-Resources)

1. Photoshop: https://www.adobe.com/africa/learn/photoshop
2. Blender : https://docs.blender.org/manual/en/latest/index.html
3. Blender : https://studio.blender.org/training/animation-fundamentals/
4. Unity: https://docs.unity3d.com/6000.0/Documentation/Manual/UnityManual.html

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2024 Course)		
MDM-221-CDS : Digital Electronics and Logic Design		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week	02	**CCE** : 30 Marks **End-Semester**: 70 Marks

Prerequisite Courses :

1. Basic Electronics Engineering (ESE-101-ETC)

Course Objectives: The course aims to introduce engineering students to the fundamentals of Digital electronics technology, enhance problem-solving abilities, and provide a strong foundation for careers in computing, automation, and embedded systems.

1. To study number systems and develop skills for design and implementation of combinational logic circuits and sequential circuits.
2. To introduce programmable logic design and ASM chart ans synchronous state machines.
3. To introduce students to basics of microprocessors.

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

- CO1: **Simplify** Boolean Expressions using K Map.
- CO2: **Design** and implement combinational circuits.
- CO3: **Design** and implement sequential circuits.
- CO4: **Develop** simple real-world application using ASM and PLD.
- CO4: **Explain** organization and architecture of computer system.

Course Contents

Unit I - Minimization Technique (06 Hours)

Logic Design Minimization Technique: Minimization of Boolean function using K-map (up to 4 variables) and Quine Mc-Clusky Method, Representation of signed number- sign magnitude representation ,1's complement and 2's complement form, Sum of product and Product of sum form, Minimization of SOP and POS using K-map.

Case Study: Digital locks using logic gate

Unit II - Combinational Logic Design (06 Hours)

Code converter-: BCD, Excess-3, Gray code, Binary Code. Half- Adder, Full Adder, Half Subtractor, Full Subtractor, Binary Adder (IC 7483), BCD adder, Look ahead carry generator, Multiplexers (MUX): MUX (IC 74153, 74151), Cascading multiplexers, Demultiplexers (DEMUX)- Decoder (IC 74138, IC 74154), Implementation of SOP and POS using MUX, DMUX, Comparators (2 bit), Parity generators and Checker.

Case Study :Combinational Logic Design of BCD to 7-segment display Controller

Unit III - Sequential Logic Design (06 Hours)

Flip-Flop: SR, JK, D, T, Master Slave JK Flip Flops, Truth Tables and Excitation tables, Conversion from one type to another type of Flop-Flop. Registers: SISO, SIPO, PISO, PIPO, Shift Registers, Bidirectional Shift Register, Ring Counter, Counters: Asynchronous Counter, Synchronous Counter, BCD Counter, JohnsonCounter, Modulus of the counter (IC 7490), Synchronous Sequential Circuit Design :Models- Moore and Mealy, State diagram and State Table ,Design Procedure, Sequence Generator and detector.

Case study: Electronic Voting Machine

Unit IV - Algorithmic State Machines and PLDs (06Hours)

Algorithmic State Machines: Finite State Machines (FSM) and ASM, ASM charts, notations, construction of ASM chart and realization for sequential circuits.

PLDS : PLD, ROM as PLD, Programmable Logic Array (PLA), Programmable Array Logic (PAL), Designing combinational circuits using PLDs.

Case Study : Wave form generator using MUX controller method

Unit V -Introduction to Computer Architecture (06 Hours)

Introduction to Ideal Microprocessor – Data Bus, Address Bus, Control Bus. Microprocessor based Systems – Basic Operation, Microprocessor operation, Block Diagram of Microprocessor. Functional **Units of Microprocessor –** ALU using IC 74181, Basic Arithmetic operations using ALU IC 74181, 4-bit Multiplier circuit using ALU and shift registers. Memory Organization and Operations, digital circuit using decoder and registers for memory operations

Case study : Microprocessor based system in real-time milk collection system

Learning Resources

- **Text Books:**

1. R.P.Jain, " Modern Digital Electronics", Tata McGraw Hill 4th Edition, ISBN 978-0-07-06691-16
2. Moris Mano, "Digital Logic and Computer Design", Pearson , ISBN 978-93-325-4252-5

- **Reference Books:**

1. D. Leach, Malvino, Saha, "Digital Principles and Applications"||, Tata McGraw Hill, ISBN – 13:978-0-07-014170-4.
2. Norman B and Bradley, "Digital Logic Design Principles", Wiley, ISBN:978-81-265-1258

- **e-Books:**

1. https://www.springer.com/gp/book/9783030361952

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

1. Digital Circuits, by Prof. Santanu Chattopadhyay, https://swayam.gov.in/nd1_noc19_ee51/preview
2. Digital Circuits and Systems,Prof. S. Srinivasan, https://nptel.ac.in/courses/117/106/117106086/
3. Microprocessors and Interfacing By Prof. Shaik Rafi Ahamed | IIT Guwahati, https://swayam.gov.in/nd1_noc20_ee11/previe

Savitribai Phule Pune University Second Year of Computer Science and Engineering(Data Science) (2024 Course)		
EEM-231- CDS : Entrepreneurship Development		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 2 Hours/Week **Tutorials** : 1 Hour/Week	02	**Term Work** : 25 Marks

Course Objectives: The course aims to:

1. Introduce the fundamental principles of entrepreneurship, forms of business organizations, and the startup ecosystem.
2. Enable students to identify, evaluate, and select viable business opportunities using structured techniques.
3. Familiarize students with business models, financial planning, and market validation strategies.
4. Expose students to key marketing strategies, customer acquisition techniques, and branding essentials for startups
5. Develop student's 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

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

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

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

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

Crafting an Elevator Pitch: Definition and purpose, Key elements: Problem, solution, value proposition, target audience, Delivery tips: Clarity, brevity, confidence
Storytelling & Communication: Importance of Storytelling in Business, Structure of a Business Story: Setup, Conflict, Resolution. Communication Skills: Verbal and Non-verbal
Overview of Funding Sources: Public & private capital sources, venture capital, debt financing. Bootstrapping: Meaning, benefits, and risks, Angel investors: Role, expectations, approach, Brief on incubators, government schemes, crowdfunding.

Case study:

1. Shark Tank India – Pitch Analysis (Any Season)
2. Airbnb – The Original Pitch Deck
3. Dropbox – Storytelling Through Demonstration
4. Dunzo – Investor Pitch Evolution

Learning Resources

Text Books:

1. Bygrave, W.D., Zacharakis, A., & Corbett, A.C. Entrepreneurship, 6th Edition, Wiley, 2025. ISBN: 9781394262809.
2. Drucker, Peter F. Innovation and Entrepreneurship: Practice and Principles, Reprint Edition, Harper Business, 2006. ISBN: 9780060851132.
3. Osterwalder, Alexander & Pigneur, Yves. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, 1st Edition, Wiley, 2010. ISBN: 9780470876411.

Reference Books:

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

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

MOOC / NPTEL/YouTube Links: -

1. Entrepreneurship Essentials By Prof. Manoj Kumar Mondal IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc20_ge08/preview
2. Entrepreneurship By Prof. C Bhaktavatsala Rao
   IIT Madras https://onlinecourses.nptel.ac.in/noc21_mg70/preview
3. https://onlinecourses.nptel.ac.in/noc20_mg35
4. https://www.coursera.org/learn/entrepreneur-guide-beginners
5. https://wadhwanifoundation.org/

YouTube/Video Links

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

List of Assignments

No	Title	Objective	Description
1	Entrepreneurial Mindset Reflection	To encourage students to explore their personal views on entrepreneurship and recognize the key characteristics of an entrepreneurial mindset by studying the journey of a real-world entrepreneur.	**Write a reflective essay** (500–600 words) based on the following: • Explain what entrepreneurship means to you personally. • Identify an entrepreneur (Indian or global) whom you admire and explain the reasons for your admiration. • Highlight specific mindset traits (e.g., risk-taking, resilience, innovation, adaptability) that contributed to this entrepreneur's success. • Reflect on how these traits align with your own strengths or indicate areas you wish to develop.
2	Idea Generation Challenge	To foster creativity, structured brainstorming, and the ability to identify potential business opportunities based on real-world problems.	**Generate 10 Business Ideas** Use any structured brainstorming technique Ideas can be tech-based, social impact, service-based, or product-based 2. Select One Idea- Choose the most promising idea from your list 3. Write a 1-page Concept Summary, include the following: • Problem Identified: Describe the specific problem or pain point your idea addresses. • Solution Overview: Briefly describe your business idea. • Target Audience: Identify the group of people or organizations that would benefit. • Market Potential: Discuss the viability and scalability of the idea.
3	Business Model & Customer Validation	To help students develop a clear, structured business model and test its assumptions through customer conversations. The goal is to learn how to validate ideas through real-world feedback and refine the business concept accordingly.	**Part A: Business Model Canvas** 1. Choose a business idea (from Assignment 2 or a new one). 2. Create a Business Model Canvas with all 9 key blocks: o Customer Segments o Value Propositions o Channels o Customer Relationships o Revenue Streams o Key Resources o Key Activities o Key Partnerships o Cost Structure 3. Present the BMC in visual or tabular format.

			Part B: Customer Interviews & Insights 1. Identify 2–3 potential customers from your target segment. 2. Conduct brief interviews (5–10 minutes each) to gather insights on: o Their pain points o Their reaction to your proposed solution o Willingness to pay or use your product/service 3. Summarize findings in a 1–1.5 page report that includes: o Key customer quotes or paraphrased insights o A revised Value Proposition or Customer Segment block (if needed) o A short reflection: key learnings and potential changes to your idea
4	Business Launch Plan – Marketing & Financial Snapshot	To develop a practical understanding of how marketing stratey and financial planning go hand-in-hand in launching a startup. Students will define a basic marketing campaign and align it with estimated costs, pricing, and projected revenue.	You are preparing to launch your business idea. Prepare a combined Marketing and Financial Snapshot including the following **Part A: Marketing Campaign Plan** • Define your target market by identifying primary customers. • Design a mini-campaign using one or more of the following channels: Social media (e.g., Instagram, LinkedIn) Print/digital flyers Email marketing • Describe the campaign content, including the message or offer to be promoted. • Optionally, create 1–2 sample marketing materials. • Write a 300-word explanation outlining your marketing strategy and expected impact.
			Part B: Financial Snapshot 1. Startup Costs – Estimate your initial costs (fixed + variable) 2. Pricing Strategy – State your pricing model and justification 3. Break-even Analysis – Basic cost vs. sales estimate 4. 6-Month Revenue Projection – Expected sales and income 5. Format: Use a simple table or spreadsheet (optional)
5	Elevator Pitch Video	To help students develop confidence and clarity in presenting their business idea in a short, compelling format. The exercise simulates real-world investor or networking scenarios where entrepreneurs must grab attention quickly.	**Prepare a 90-second elevator pitch for your business idea** (the same or refined idea used in earlier assignments). Your pitch should cover the following elements: o The Problem – Problem Identification o The Solution – Description of your product/service. o Value Proposition – The unique value proposition. o Target Audience – Audience for your idea. o Call to Action – E.g. request for support, funding, feedback, etc. **Deliver Your Pitch:** o Record a video and submit it with written version of your pitch. o Ensure clear speech, confident body language (for video), and persuasive tone. **Reflection (Short Write-up):** o Share what you learned about communicating your idea o Describe challenges or rewards you experienced in the process

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2024 Course)		
VEC-232-CDS: 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 (03 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 (03 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 (03Hours)

(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) (03 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/aic22_ge23/preview
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/109104068

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
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 a 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	Exploring Sources of Imagination in the Self 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?	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.
7	Exploring the Feeling of Trust Show & discuss the video "Right Here Right Now". It is a short film directed by Anand Gandhi about human behaviour and its propagation. www.youtube.com/watch?v=OVAokeqQuFM www.youtube.com/watch?v=gIYJePEnvUY).	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 100% response in human-human interaction and make effort towards it.
8	Exploring the Feeling of Respect 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?	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.
9	Exploring Systems to fulfil Human Goal 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.	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.

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 Computer Science and Engineering(Data Science) (2024 Course)		
CEF-241- CDS: : Community Engagement Project		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 04 Hours/Week	02	**Term Work :** 25 Marks **Oral :** 25 Marks

Companion Course :

1. CEP is an experiential learning approach that combines education, learning, community development, and meaningful community service.
2. Project involves students in community development and service activities and applies the experience to personal and academic development.
3. The targeted contribution of college students to the village/local development will benefit the community.
4. 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. CO1 - **Identify** and **Analyze** local community needs and challenges by engaging with stakeholders and evaluating real-world problems.
2. CO2- **Design** and **Implement** practical, creative, and context-specific solutions using engineering principles to address community issues.
3. CO3 - **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 or a single student 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 is allotted to a faculty member of the department as a mentor.
- 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.

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

- Use and/or miss-use of cell phones
- Career orientation of youth
- Water facilities and drinking water availability
- Health and hygiene of the school going students, home makers and old personals
- Health intervention and awareness programmes
- Horticulture
- Herbal and Nutrition
- Traditional and Modern health care methods
- Food habits
- Air /Sound /Water pollution
- Plantation and Soil protection
- Renewable energy and Solar Systems
- Yoga awareness and practice
- Health care awareness programmes and their impact
- Organic farming
- Food adulteration
- Incidence of Diabetes and other chronic diseases
- Blood groups and blood levels
- Chemicals in daily life
- Music and dance
- 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 - Computer Science and Engineering (Data Science)

2024 Pattern

Semester IV

With effect from Academic Year 2025-26

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2024 Course)		
PCC-251- CDS: Database Management Systems		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03Hours/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 understand database concepts, design principles, and ER/EER modeling.
2. To develop SQL and PL/SQL skills for efficient database operations and procedural programming.
3. To apply normalization techniques for designing well-structured relational databases.
4. To explore database transactions, concurrency control methods, and recovery mechanisms.
5. To analyse NoSQL database models and their role in managing unstructured data.

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

- CO1: **Explain** the fundamentals of database management systems, including data models, ER modeling, and database design.
- CO2: **Develop** and **execute** SQL and PL/SQL programs to manage and manipulate relational data.
- CO3: **Apply** normalization techniques to improve database design and ensure data integrity.
- CO4: **Analyze** transaction management concepts and concurrency control techniques for reliable database systems
- CO5: **Evaluate** NoSQL database types and **explain** their suitability for handling unstructured data.

Course Contents

Unit I - Introduction to Database Management System (09 Hours)

Introduction to Database Management Systems, Purpose of Database Systems, Database-System Applications, View of Data, Database Languages, Database System Structure, Enterprise Constraints Data Models, Database Design and ER Model: Entity, Attributes, Relationships, Constraints, Keys, Design Process, Entity Relationship Model, ER Diagram, Design Issues, Extended E-R Features, Converting E-R & EER diagram into tables.

Case Study: Study of Architecture of any DBMS like Oracle or MySQL. Design a database schema for any problem given in previous Question Papers.

Unit II - SQL and PL/SQL (09 Hours)

SQL: DDL, DML, Select Queries, String, Date and Numerical Functions, Aggregate Functions ,View, Indexes, Group by and Having Clause, Join Queries, Set, Set operation, Set membership, Nested queries, DCL, TCL
PL/SQL: Control Statement, Cursor, Stored Procedure and Function, Trigger

Case Study : Design and implement a Student Course Management System using SQL and PL/SQL to manage students, courses, and faculty members efficiently. The system should store and retrieve relevant data, ensuring integrity, security, and performance optimization.

Unit III - Relational Database Design (09 Hours)

Relational Model: Basic concepts, Attributes and Domains, CODD's Rules, Relational Integrity, Referential Integrities, Database Design: Features of Good Relational Designs, Normalization, Atomic Domains and First Normal Form, Decomposition using Functional Dependencies, 2NF, 3NF, BCNF.

Case study: Design and Optimization of a Relational Database for a University Management System

Unit IV - Database Transactions (09 Hours)

Basic concept of a Transaction, Transaction Management, Properties of Transactions, ACID, Concept of Schedule, Serial Schedule, Serializability: Conflict and View, Cascaded Aborts, Recoverable and Non-recoverable Schedules, Concurrency Control: Need, Locking Methods.

Case study : Design Online Shopping Cart Transaction Management In an e-commerce platform, multiple users simultaneously add, update, and purchase products. To ensure data consistency and reliability, the system must handle concurrent transactions effectively.

Unit V - NoSQL Database (09 Hours)

Introduction to NoSQL Database, NoSQL data models, CAP theorem and BASE Properties, Comparative study of SQL and NoSQL, MongoDB: CRUD Operations, Indexing and Aggregation.

Case study: Study NoSQL Database Selection for a Social Media Platform.

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. D T Editorial Services "BIG DATA Black Book", Dreamtech Press ISBN 13 : 9789351199311

Reference Books:

1. C J Date, “An Introduction to Database Systems”, Addison-Wesley, ISBN: 0201144719
2. S.K.Singh, “Database Systems: Concepts, Design and Application”, Pearson Education, ISBN 978-81-317-6092-5
3. Kristina Chodorow, Michael Dierolf, “MongoDB: The Definitive Guide”, O Reilly Publications, ISBN: 978-1-449-34468-9
4. Adam Fowler, “NoSQL For Dummies”, John Wiley & Sons, ISBN-1118905628
5. Kevin Roebuck, “Storing and Managing Big Data - NoSQL, HADOOP and More”, Emereopty Limited, ISBN: 1743045743, 9781743045749
6. Joy A. Kreibich, “Using SQLite”, O’REILLY, ISBN: 13:978-93-5110-934-1
7. Ivan Bayross, “SQL, PL/SQL the Programming Language of Oracle”, BPB Publications ISBN: 9788176569644, 9788176569644

MOOC / NPTEL/YouTube Links: -

1. https://nptel.ac.in/courses/106106220
2. https://nptel.ac.in/courses/106105175
3. https://www.mongodb.com/resources/basics/databases/nosql-explained
4. https://learn.microsoft.com/en-us/azure/cosmos-db/nosql/modeling-data
5. http://www.nptelvideos.com/lecture.php?id=6518

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2024 Course)		
PCC-252- CDS: System Programming and Operating Systems		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week	02	**CCE** : 30 Marks **End-Semester:** 70 Marks

Prerequisite Courses : Programming and Problem Solving, Data Structures and Algorithms, Principles of Programming Languages.

Companion Course : System Programming & Operating System Laboratory
Course Objectives: The course aims to:

1. To get acquainted with the basics of System Programming.
2. To acquire knowledge of data structures used in the design of System Software.
3. To comprehend the structures and functions of Operating Systems and process management.
4. To deal with concurrency in the Operating System.
5. To learn and understand memory management of Operating System.

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

- CO1: Analyze and synthesize basic System Software and its functionality.
- CO2: Compare different loading schemes and analyze the performance of loader.
- CO3: Compare and illustrate various processes & Threads.
- CO4: Identify the mechanism for concurrency issues and Implement and Analyze the performance of process scheduling algorithms.
- CO5: Apply appropriate memory and file management schemes.

Course Contents

Unit I - Introduction (06 Hours)

Introduction to Systems Programming, Need of systems programming, Software Hierarchy, Types of software: system software and application software, Machine structure. Evolution of components of systems programming: Text Editors, Assembler, Macros, Compiler, Interpreter, Loader, Linker, Debugger, Device Drivers, Operating System. Elements of Assembly Language Programming: Assembly Language statements, Benefits of Assembly Language, A simple Assembly scheme, Pass Structure of Assembler.

Case studies: Study of Debugging tools like GDB

Unit II - Compilers and Loaders (06 Hours)

Introduction to Compilers: Phases of Compiler with example, Comparison of compiler and Interpreter. Loader schemes: Compile and Go, General Loader Scheme, Absolute Loaders, Subroutine Linkages,
Relocating Loaders, Direct linking Loaders, Overlay structure, Design of an Absolute Loader, Design of Direct linking Loader, Self-relocating programs, Static and Dynamic linking.

Cast Studies - Study the concepts of Class loading in Java .

Unit III - Overview, Processes & Threads (06 Hours)

Operating System (OS) Objectives, Evolution, Types, Major Achievements, Modern Operating Systems, Virtual Machines. Process Concept, Process States, Process Description, Process Control Block, PCB as a Data Structure in Contemporary Operating Systems, Process Hierarchy, Processes vs Threads, Types of Threads.

Case Studies - Linux & Windows Process and Thread Management and its Related System Calls.

Unit IV - Concurrency & Scheduling (06 Hours)

Concurrency: Principles of Concurrency, Mutual Exclusion, Semaphores, Monitors, Message Passing, Readers/Writers Problem.
Scheduling: Uniprocessor Scheduling: Long Term Scheduling, Medium Term Scheduling, Short Term Scheduling, Scheduling Algorithms: Short Term Scheduling Criteria, Use of Priorities, Alternative
Scheduling Policies, Performance Comparison, Fair-Share Scheduling.

Case study : Linux & Windows Scheduling

Unit V - Memory & File Management (06 Hours)

Memory Management: Memory Hierarchy, Static and Dynamic Memory Allocation, Overview of Swapping, Multiple Partitions, Contiguous and Non-Contiguous Memory Allocation, Placement Strategies: First Fit, Best Fit, Next Fit and Worst Fit.

Virtual Memory (VM): Concepts, Swapping, VM with Paging, Page Table Structure.

Page Replacement Policies: First In First Out (FIFO), Least Recently Used (LRU) and Optimal.

File Management: Overview of Files & File Systems, File Structure, File Management Systems, File Organisation and Access, File Directories, File Sharing.

Case Studies - Linux & Windows File System

Learning Resources

Text Books:

1. John Donovan, “System Programming”, McGraw Hill, ISBN 978-0--07-460482-3.
2. Dhamdhere D., "Systems Programming and Operating Systems", McGraw Hill, ISBN 0 - 07 463579 – 4
3. Silberschatz, Galvin, Gagne, "Operating System Principles", 9th Edition, Wiley, ISBN 978- i. 1-118-06333-0
4. Silberschatz, Galvin and Gagne, "Operating System Concepts", 10/E, John Wiley & Sons, 2018.
5. W. Stallings, "Operating Systems: Internals and Design Principles", 9/E, Pearson Pub., 2017.
6. W Richard Stevens, Stephen A Rago, "Advanced Programming in the UNIX Environment";3/E, Addison Wesley Professional, 2013.
7. Kernighan & Pike, "UNIX programming Environment", 2/E, PHI-EEE, 2001.

Reference Books:

1. Leland Beck, “System Software: An Introduction to systems programming”, Pearson.
2. John R. Levine, Tony Mason, Doug Brown, “Lex & Yacc”, 1st Edition, O’REILLY, ISBN 81- i. 7366-062-X.
3. Alfred V. Aho, Ravi Sethi, Reffrey D. Ullman, “Compilers Principles, Techniques, and Tools”, i. Addison Wesley, ISBN 981-235-885-4
4. Crawley, "Operating Systems - A Design Oriented Approach", 1/E, McGraw Hill, 1998.Joy A. Kreibich, “Using SQLite”, O’REILLY, ISBN: 13:978-93-5110-934-1
5. Coulouris, George F."Distributed Systems:Concepts and Design". Boston: Addison-Wesley, 5th edition.
6. Edward Rutherglen, Dean Wampler, Jason Rutherglen and Edward Capriolo, Programming "Hive: Data Warehouse and Query Language for Hadoop", O’REILLY Publishers, 1th edition.

E-Book

1. https://www.elsevier.com/books/systems-programming/anthony/978-0-12-800729-7
2. https://www.kobo.com/us/en/ebook/linux-system-programming-1
3. https://www.ebooks.com/en-us/subjects/computers-operating-systems-ebooks/279/
4. https://www.e-booksdirectory.com/details.php?ebook=9907f

MOOC/NPTEL/SWAYAM Course Links:

1. https://www.udacity.com/course/introduction-to-operating-systems--ud923
2. Nptel video lecture link: https://nptel.ac.in/courses/106/105/106105214/
3. https://www.edx.org/course/computer-hardware-and-operating-systems
4. https://onlinecourses.nptel.ac.in/noc19_cs50/preview
5. https://www.udemy.com/course/system-programming/

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2024 Course)		
PCC-253-CDS: Mathematical Foundation for Data Science		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03Hours/Week	03	**CCE** : 30 Marks **End-Semester**: 70 Marks

Prerequisite Courses : Students should have prior knowledge of Basic Mathematics,Basic linear algebra, Basic calculus:

Course Objectives: The course aims to introduce several Discrete Mathematical Structures found to be serving as tools even today in the development of theoretical computer science.

1. **Develop** proficiency in applying fundamental probability theorems such as Bayes' Theorem, Law of Total Probability, and Conditional Probability, to solve real-world problems in decision-making and risk analysis.
2. **Apply and Analyze** statistical principles and concepts essential for understanding data behavior, distributions, and analytical methods that underpin statistical analysis.
3. **Gain** the ability to conduct advanced statistical analyses such as correlation and regression, to explore relationships between variables and derive predictive insights.
4. **Understand** the key principles of random variables and processes including how to differentiate between types of random variables, and apply probability distributions to model and interpret real-world scenarios.
5. **Apply** probability and statistical methods effectively to analyze complex data sets and make informed decisions across diverse industries, including finance, engineering, healthcare, and machine learning

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

- CO1: **Utilize** key probability theorems, including Bayes' Theorem, Law of Total Probability, and Conditional Probability, to solve practical problems in decision-making and risk analysis.
- CO2: **Understand** all fundamentals of Statistics.
- CO3: **Apply** statistical techniques such as correlation and regression analysis to examine relationships between variables and make predictions.
- CO4: **Demonstrate** basic principles of random variables and random processes needed in applications, differentiating between random variables, and applying probability distributions to model and interpret real-world scenarios.
- CO5: **Use** probability and statistical models to analyze data and support decision-making in fields like finance, engineering, healthcare, and machine learning.

Course Contents

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

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

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

Case studies:

1. How probability is used in real-life situations regularly. Ex: Weather Forecasting, Sports Betting, etc.
2. Case Study: Given past data on fraudulent and non-fraudulent transactions, Explore how Bayes' Theorem can be applied to update the probability of fraud based on new evidence

Unit II - Introduction to Statistics (09 Hours)

Introduction to Statistics: Introduction, Origin and Development and scope of Statistics, Population and Sample, Sampling –Introduction, Types of Sampling, Purposive Sampling, Random Sampling, Simple Sampling, Stratified Sampling, Parameter and Statistic, Sampling Distribution, Sampling With and Without Replacement, Population Parameters,

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

Cast Study

1. Create Measures of central tendency for a real life example dataset like the payroll dataset or titanic dataset etc.
2. Case study of sampling for any real-world problem like exit poll statistics

Unit III - Descriptive Statistics (09 Hours)

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

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

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

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

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

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

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

Unit V - Inferential Statistics (09 Hours)

Hypothesis and Testing of Hypothesis: Introduction, Statistical Hypothesis (Simple and-Composite), Test of a Statistical Hypothesis, Null Hypothesis, Alternative Hypothesis, Critical Region, Two Types of Errors, level of Significance, Power of the Test. Steps in Solving Testing of Hypothesis Problem, Optimum Tests Under Different Situations, Most Powerful Test (MP Test), Uniformly Most Powerful Test, Likelihood Ratio Test, Properties of Likelihood Ratio Test. Neyman-Pearson Fundamental Lemma, Test for the Mean of a Normal Population, Test for the Equality of Means of Two Normal Populations, Test for the Variance of a Normal Population, Test for Equality of Variances of two Normal Populations, Non-parametric Methods, Advantages and Disadvantages of Non-parametric Methods.

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

Learning Resources

Text Books:

1. S. C. Gupta, V. K. Kapoor, "Fundamentals of Mathematical Statistics (A Modern Approach)", Sultan
2. Chand & Sons Educational Publishers, Tenth revised edition, ISBN: 81-7014-791-3.
3. J. Medhi, "Statistical Methods: An Introductory Text", Second Edition, New Age International Ltd, ISBN: 8122419577.

Reference Books

- Glen Cowan, “Statistical Data Analysis” ,University of Siegen, Clarendon Press, Oxford, 1998, ISBN: 0198501552
- Probability, random variables and stochastic processes by A. Papoulis and S.U. Pillai, TMH
- Ken Black, “Applied Business Statistics”, Wiley, 7th Edition, ISBN:788126537075
- Probability, Statistics and Random Process by T Veerarajan, TMH.
- Introduction to Probability Theory and Statistical Inference by H.J. Larson. **E-Book**

1. https://www.itl.nist.gov/div898/handbook/
2. https://web.stanford.edu/∼hastie/ElemStatLearn/index.htm.

MOOC/NPTEL/SWAYAM Course Links:

1. https://www.youtube.com/watch?v=F9BZ5JsnjYM
2. https://onlinecourses.nptel.ac.in/noc20_cs28/preview

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science)(2024 Course)		
PCC-255-CDS: System Programming and Operating System Laboratory		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	01	**Oral :** 25 Marks

Prerequisite Courses : Basics of python programming and Principles of Problem Solving

Companion Course :Systems Programming and Operating System(PCC-205-CDS)
Course Objectives: The course aims to:

1. To study basic Language Translator.
2. To learn system programming tools.
3. To learn modern operating system.
4. To implement scheduling schemes.
5. To Implement Page replacement Algorithms.

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

- CO1:**Understand** Various Language Translators.
- CO2:**Apply** LEX and YACC tools to develop lexical analyzers and parsers for programming languages.
- CO3:**Demonstrate** operating system functionalities through implementation of key modules such as process management, memory management, and file systems.

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.

Operating System recommended: - 64-bit Open-source Linux or its derivative

Programming tools recommended: - Open-Source Java, C++ Programming tool like G++/GCC

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

Sr.	Group A(Any TWO Assignments from Sr. No. 1 to 3)
1	Study of Language Processor(Assembler, Loader)
2	Write a program using Lex specifications to implement lexical analysis phase of compiler to generate tokens of subset of 'C/C++ Java' program.
3	Write a program using Lex specifications to implement lexical analysis phase of compiler to count no. of words, lines and characters of given input file.
	Group B (Any THREE Assignments from Sr. No. 4 to 7)
1	Implement Reader/Writer Problem.
2	Write a program to simulate CPU Scheduling Algorithms: 1. FCFS (Preemptive), 2. SJF (Preemptive), 3. Priority (Non-Preemptive) 4. Round Robin (Preemptive).
3	Write a program to simulate Memory placement strategies: 1. Best fit. 2. First fit. 3. Next fit. 4. Worst fit.
4	Write a program to simulate Page replacement algorithm: 1. First in First Out (FIFO). 2. Least Recently Used (LRU). 3. Optimal Page Replacement.

Learning Resources

Text Books

1. P. Raghavan, K. Sriram, and T. Ravishankar, System Programming and Operating Systems Lab Manual, Tata McGraw-Hill, 2017.
2. M. Venkateshwarlu, Operating System Laboratory Manual, Dreamtech Press, 2015.
3. Prof. Rajkamal, System Programming and Operating System Laboratory, Oxford University Press, 2016.
4. V. N. Rajasekaran, Operating System Lab Manual, New Age International, 2014.
5. P. Radha Krishna, System Programming and Operating System Lab Manual, Himalaya Publishing House, 2018.

Reference Books

MOOC/NPTEL/SWAYAM Course Links:

1. NPTEL :- https://nptel.ac.in/courses/106108101?utm_source=chatgpt.com
2. https://archive.nptel.ac.in/courses/106/102/106102132/

3. https://archive.nptel.ac.in/courses/106/106/106106144/
4. https://onlinecourses.nptel.ac.in/noc25_cs78/preview

YouTube/Video Links:

1. https://www.youtube.com/playlist?list=PLXj4XH7LcRfDKVxJJ_bf1mF-X5O2if2PR
2. https://www.youtube.com/playlist?list=PLlr7wO747mNp5nn0hteJFnt1rpdx6GG-_

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2024 Course)		
PCC-254- CDS: 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 understand and apply the concepts of database design by formulating case studies, creating E-R diagrams, and mapping them to the relational model.
2. To develop and execute SQL queries for creating, modifying, and managing database structures using DDL, DML, DCL, and TCL commands.
3. To implement advanced SQL operations, including aggregate functions, joins, subqueries, views, stored procedures, and triggers, for efficient database management.
4. To explore NoSQL databases by designing and implementing CRUD operations in MongoDB, understanding document-based storage and retrieval.

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

1. **Apply** the concepts of database design by creating E-R diagrams and converting them into relational models.
2. **Develop** and **execute** SQL queries for data manipulation, transaction control, and access management using DML, DCL, and TCL commands.
3. **Analyze** and **implement** SQL operations, including joins, views, subqueries, stored procedures, and triggers, to optimize data retrieval and integrity.
4. **Design** and **Implement** CRUD operations in MongoDB, demonstrating an understanding of NoSQL database concepts and their practical applications.

Course Contents

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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.

Operating System recommended :- 64-bit Open source Linux or its derivative
Programming tools recommended: - MYSQL/Oracle, MongoDB, ERD plus, ER Win

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

Sr.	Name of Assignment
1	**Case Study and ER Diagram** Develop a case study and design its Entity-Relationship (ER) Diagram. Convert the ER model into a relational mode
2	**Write and execute SQL Data Definition Language** (DDL) commands such as CREATE, ALTER, DROP, RENAME, and TRUNCATE to define and modify tables. Insert data into the tables and apply appropriate integrity constraints such as NOT NULL, UNIQUE, PRIMARY KEY, FOREIGN KEY, and CHECK. (The application may vary as per the subject teacher's requirement.)
3	**SQL Queries for Data Manipulation, Access Control, and Transactions** Design and run SQL queries to demonstrate the following: a) Data Manipulation (DML): Use SQL statements to INSERT, UPDATE, and DELETE records. Apply arithmetic, logical, set operators, pattern matching, and string functions. b) Access Control (DCL): Use GRANT, REVOKE, and ROLE commands to manage user access. c) Transaction Control (TCL): Apply START TRANSACTION, COMMIT, ROLLBACK, and SAVEPOINT commands to manage transactions.
4	**Aggregate Functions and Grouping** Use aggregate functions along with GROUP BY and HAVING clauses to retrieve summarized data from the database.
5	**JOIN Operations and Views** Perform various types of JOIN operations to extract meaningful relationships between tables. Create and manage different database views.

6	**Subqueries** Write and execute subqueries to retrieve data from one table based on results from another.
7	**Stored Procedures or Function with Cursors** Create and execute stored procedures / function using cursors.
8	**Database Triggers** Implement and test triggers to maintain data integrity in database.
9	**CRUD Operations using MongoDB** Design and implement basic Create, Read, Update, and Delete (CRUD) operations using MongoDB. Use the save method and logical operators where necessary.
10	**Aggregation and Indexing in MongoDB** Design and execute MongoDB queries using aggregation and indexing techniques with suitable examples.
11	Using the database concepts covered in above assignments, develop an application with following details: 1. Follow the Software Development Life cycle and other concepts learnt in Software Engineering Course throughout the implementation. 2. Develop application considering: • Front End: Java/Perl/PHP/Python/Ruby/.net/any other language • Backend : MongoDB/ MySQL/Oracle 3. Test and validate application using Manual/Automation testing. 4. Student should develop application in group of 2-3 students and submit the Project Report which will consist of documentation related to different phases of Software Development Life Cycle: • Title of the Project, Abstract, Introduction • Software Requirement Specification • Conceptual Design using ER features, Relational Model in appropriate Normalize form • Graphical User Interface, Source Code • Testing document • Conclusion

Note

• Instructor should maintain progress report of mini project throughout the semester from project group.

• The practical exam will be based on Assignments 1 through 10 provided above.

• Mini Project in this course should facilitate the Project Based Learning among students

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2024 Course)		
MDM-271-CDS - Internet of Things		
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 introduce students to the fundamental concepts and principles of the Internet of Things (IoT).
2. To familiarize students with the components and architecture of IoT systems.
3. To explore various communication protocols used in IoT.
4. To understand the role of sensors and actuators in IoT applications.
5. To analyze data processing techniques for IoT environments.
6. To demonstrate the applications of IoT in different domains such as healthcare, smart cities, agriculture, and industrial automation.

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

- CO1. **Explain** the concept of the Internet of Things (IoT) and its significance in modern technology.
- CO2: **Design and Implement** basic IoT solutions using sensors and actuators.
- CO2: **Design and Implement** basic IoT solutions using sensors and actuators
- CO3: **Design and Implement** basic IoT solutions using sensors and actuators
- CO4: **Implement** an architectural design for IoT for specified requirement.
- CO5: **Choose** between available technologies and devices for stated IoT challenge

Course Contents

Unit I - Introduction Internet of Things (06 Hours)

IoT: Definition and characteristics of IoT, Internet of Things: Vision, Emerging Trends, Economic Significance, Technical Building Blocks, Physical design of IoT, Things of IoT, IoT Protocols, Logical design
of IoT, IoT functional blocks, IoT communication models, IoT Communication APIs, IoT enabling technologies, IoT levels and deployment templates, IoT Issues and Challenges, Applications.

Case Study: Know about the great philosophers-Dirichlet

Unit II - IoT Sensors and Physical Devices (06 Hours)

Introduction, Selection Criteria for Sensors, Working and applications of sensors-IR sensor, LDR sensor, PIR motion sensor, Ultrasonic Distance Sensor, Gyro sensors, Digital Humidity and Temperature sensor, Analog to Digital Conversion, Sensor data acquisition and processing, Working and application of actuators, Servo Motors, Solenoid, Stepper Motor, DC motor, Need of Relay with actuators
IoT Physical Devices and Endpoints: Basic building blocks of and IoT device, Exemplary device: Raspberry Pi, Arduino, Raspberry Pi interfaces, Programming Raspberry Pi and Arduino with Python, Other IoT Devices.

Case Study : Explore various automatic appliance control systems

Unit III - Pillars of IoT (06Hours)

Horizontal, verticals and four pillars of IoT, M2M: The internet of devices, RFID: The internet of objects, WSN: The internet of transducer, SCADA: The internet of controllers, DCM: Device, Connect and Manage, Device: Things that talk, connect: Pervasive Network, Manage: To create business values.

Case study: Understanding and Mitigating Security Risks of General Messaging Protocols on IoT Clouds

Unit IV - IoT Protocols and Security (06 Hours)

Messaging Protocols: MQTT (Message Queuing Telemetry Transport), COAP (Constrained Application Protocol),HTTP (Hypertext Transfer Protocol),Comparison and selection criteria for protocols, Transport Protocols- Bluetooth Low Energy (BLE), Li-Fi, Difference between Li-Fi and Wi-Fi

IoT Security: Vulnerabilities of IoT, Security Requirements, Challenges for Secure IoT, Threat Modelling, Key elements of IoT Security: Identity establishment, Access control, Data and message security, non-repudiation and availability, Security model for IoT.

Case study : LoRa based Smart Irrigation System.

Unit V -Web of Things and Cloud of Things (06 Hours)

IWeb of Things versus Internet of Things, Two Pillars of the Web, Architecture Standardization for WoT, Platform Middleware for WoT, Unified Multitier WoT Architecture, WoT Portals and Business Intelligence.

Cloud of Things: Grid/SOA and Cloud Computing, Cloud Middleware, Cloud Standards – Cloud Providers and Systems, Mobile Cloud Computing, The Cloud of Things Architecture.

Case study: Smart parking, Forest fire detection

Learning Resources

Text Books:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on Approach”, Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, 2nd Edition, Wiley Publication, ISBN: 978-1-119-99435-0.

Reference Books:

1. Dawoud Shenouda Dawoud, Peter Dawoud, “Microcontroller and Smart Home Networks”, ISBN: 9788770221566, e-ISBN: 9788770221559.
2. Charles Crowell, “IoT-Internet of Things for Beginners: An Easy-to-Understand Introduction to IoT”, ISBN-13 : 979-8613100194.
3. David Hanes, Gonzalo Salgueiro, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Cisco Press, ISBN-13: 978-158714-456-1 ISBN-10: 1-58714-456-5.
4. David Etter, “IoT Security: Practical guide book”, amazon kindle Page numbers, source ISBN: 1540335011.Brian Russell, Drew Van Duren, “Practical Internet of Things Security”, Second Edition, Packt Publishing, ISBN: 9781788625821.
5. Brian Russell, Drew Van Duren, “Practical Internet of Things Security”, Second Edition, Packt Publishing, ISBN: 9781788625821.
6. Dr. Shriram K Vasudevan,Abhishek S Nagarajan, RMD Sundaram, “Internet of Things”, Wiley publication, 2nd Edition, ISBN: 9789388991018.

eBooks:

1. https://www.iotforall.com/ebooks/an-introduction-to-iot.
2. https://www.qorvo.com/design-hub/ebooks/internet-of-things-for-dummies

MOOC / NPTEL/YouTube Links: -

1. https://nptel.ac.in/courses/106/105/106105166/
2. https://www.udemy.com/course/a-complete-course-on-an-iot-system-design-and- development/
3. https://www.coursera.org/learn/iot
4. https://nptel.ac.in/courses/108/108/108108098/

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 Computer Science and Engineering (Data Science) (2024 Course)		
VSE- 281 -CDS: Object Oriented Programming (Java)		
Teaching /scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	02	**Term Work** : 25 Marks **Practical :** 25 Marks

Prerequisite Courses, if any :

1. Fundamentals of Programming languages (ESC-105- COM)
2. Programming and Problem Solving (PCC-151-ITT)

Course Objectives: The course aims to:

1. To explore & understand the principles of Object-Oriented Programming (OOP).
2. To apply the object-oriented paradigm in program design.
3. To provide object-oriented programming insight using Java.
4. To lay a foundation for advanced java programming.

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

- CO1: To apply fundamental Java programming concepts such as variables, data types, control structures, arrays, and methods to solve basic computational problems..
- CO2: To Demonstrate the use of object-oriented programming principles such as encapsulation, inheritance, polymorphism, and abstraction in real-world applications.
- CO3: To Implement method overloading, overriding, and interface concepts in Java to create flexible and reusable software components.
- CO4: To apply Handle exceptions and errors effectively using Java's exception-handling mechanisms to ensure robust and error-free applications.
- CO5: To connect Develop mini-projects using advanced features like multithreading, file handling, GUI (JavaFX), and external libraries for practical real-world applications.

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.

The instructor should allocate either one hour for theory concept according to practical assignments and one hour for practical per session, OR Two hours of theory per week, from the total four-hour weekly schedule.

Group A: Basic-level assignments focusing on fundamental concepts and syntax of Object-Oriented Programming in Java.

Group B: Intermediate assignments involving real-world problem-solving, data structures, and algorithmic implementation.

Group C: Advanced assignments that encourage innovative applications, domain-specific projects, and integration with emerging technologies.

Operating System recommended:

Programming tools recommended: As per Lab requirement add more details

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 Assignment	
Sr	**Group A - Any THREE (from 1 to 5)**
1	Implement a Java calculator program that allows users to perform basic arithmetic operations.
2	Write a Java program that prints all real solutions to the quadratic equation ax2+bx+c = 0. Read in a, b, c and use the quadratic formula. If the discriminate b2-4ac is negative, display a message stating that there are no real solutions?
3	Write a Java program to define a Rectangle class with private length and width variables, using get and set methods to calculate and display the area.
4	Develop a Java program to create a database of student information like roll number, name, age, mobile number, and blood group etc. with data initialization through multiple constructors and displays their information in a structured format.
5	Write a Java program using multiple constructors to initialize complex numbers and perform arithmetic operations like addition, subtraction and multiplication.
6	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.
7	Develop a Java program that performs various operations on arrays, including displaying elements, finding the maximum and minimum element, calculating the sum and average of elements, and searching for a specific element within the array.
8	Develop a class hierarchy for a Library Management System: 1. Book (base class) with attributes like title, author, and ISBN. 2. EBook (subclass) with additional attributes like fileSize and format. 3. PrintedBook (subclass) with attributes like number of pages and cover type. 4. Override the displayDetails() method to show different book details.
9	Design a Student Management System where each student has attributes like name, roll number, marks, and grade. Implement a class Student with methods to calculate the grade based on marks and display student details.
10	Create a BankAccount class that stores account number, holder's name, and balance as private fields. Implement getter and setter methods to allow controlled access and prevent unauthorized modifications. Add methods for deposit and withdrawal with balance validation.

Sr.	**Group B - (Any Three)**
1	Create a Java program demonstrating single inheritance where a subclass extends a superclass and calls its methods.
2	Create a Calculator class that supports: 1. **Method Overloading**: Implement add() methods that accept different parameter types (int, double, three numbers). 2.**Method Overriding:** Extend the class to ScientificCalculator, which overrides the add() method to include logarithmic addition.
3	Design a BankTransaction class that performs deposits and withdrawals. Implement custom exceptions: 1. InsufficientFundsException if withdrawal exceeds the balance. 2. InvalidAmountException if deposit/withdrawal is negative.
4	Develop a Vehicle system where: • Vehicle is an abstract class with abstract methods start() and stop(). • Car and Bike inherit from Vehicle and provide concrete implementations. • FuelEfficiency is an interface with a method calculateFuelEfficiency(), implemented by Car and Bike.

Sr.	**Group C - (Any Two)**
1	Online Shopping System: Develop a Java application that simulates an online shopping system.
2	Weather Data Visualization: Create a Java application that reads weather data from a CSV file and rforms 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.
3	Simulate a Railway Ticket Booking System where multiple users try to book seats simultaneously. Use synchronized methods to handle concurrency.
4	Develop a Hospital Management System with OOP principles: 1. Classes: Doctor, Patient, Appointment. 2. Encapsulation: Secure patient data. 3. Inheritance: SpecialistDoctor extends Doctor. 4. Polymorphism: Different consultation charges for General and Specialist doctors 5. File Handling: Save patient records

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
3. Dr. Samit Bhattacharya, Computer Graphics, Oxford University Press, ISBN-13: 978-0-19- 809619-1; ISBN-10: 0-19-809619-4.
4. D. Rogers, "Procedural Elements for Computer Graphics", 2ndEdition, Tata McGraw-Hill Publication, 2001, ISBN 0 – 07 – 047371 – 4.

MOOC / NPTEL/YouTube Links: -

1. "Programming in Java" (with Certification) Programming In Java: https://onlinecourses.nptel.ac.in/noc25_cs57/preview
2. https://archive.nptel.ac.in/courses/106/103/106103224/
3. https://archive.nptel.ac.in/courses/106/102/106102065/
4. https://nptel.ac.in/courses/106106090

E-Books :

1. https://www.iitg.ac.in/samit/Computer%20Graphics.pdf
2. https://open.umn.edu/opentextbooks/textbooks/introduction-to-computer-graphics
3. http://www2.cs.uidaho.edu/~jeffery/courses/324/lecture.html

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

Course Objectives: The course aims to:

अभ्यासक्रमाची उद्दिष्टे :

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

Course Contents

Unit I & II (07 & 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.

Guidelines for Ability Enhancement Courses - Modern Indian Language

Implementation Guidelines:

1. Subject teacher should frame minimum 08 assignments-based covering on all four units.
2. Scaffolding: Start with simpler tasks and gradually increase complexity. Provide necessary vocabulary and grammatical structures beforehand.
3. Differentiation: Offer varied levels of support for students with different proficiencies.
4. Pair Work & Group Work: Encourage collaborative learning and peer correction.
5. Feedback: Provide constructive feedback on all assignments, focusing on both accuracy and fluency.
6. Authentic Materials: Use real-world Marathi materials (simple songs, short videos, advertisements) as much as possible.
7. Cultural Context: Integrate cultural aspects into the assignments (e.g., describing a Marathi festival, a famous personality).
8. Fun & Engaging: Make the activities enjoyable to keep students motivated. Use games and competitive elements where appropriate.
9. Technology Integration: Use online dictionaries, translation tools (with caution), and Marathi typing tools.
10. These assignments can be adapted based on the students' proficiency level and the specific learning objectives of the Marathi course.

Suggested List of Assignments :

1. "Samvad Sadara Kara" (Present a Dialogue): Role-Playing Everyday Scenarios: Objective is to practice conversational Marathi, understanding social cues. In pairs or small groups, students create and perform a short dialogue based on a given scenario.
2. Vartamanpatra Vachan" (Newspaper Reading): (Columns like Sports, political, finance, editorial, education, international news etc) in the daily Marathi newspapers, summarize and present in the practical. A summary should be added as part of the journal.
3. Creative writing: Write blogs and posts on social media up to 200 words on recent development in their field of study
4. "Mala He Sangayche Aahe" (I Want to Say This): Students are expected to show the objects and describe it to the class in Marathi. They should mention its color, size, use, why it's important to them, etc.
5. Professional letter / report writing
   (a) Write a letter to the principal/director for organizing NSS camp in nearby village. Preparation of the budget, permission letters and report submission in the University
   (b) Write a letter for internship sponsorship to any organization.
6. Book Review – Students are expected to read any novel, fiction or literature book of their choice and write a review on post it on social media of their choice.
7. Participation in Competitions (in college/out side the college) debate, declamation, elocution – A Report should be submitted
8. Group Activity: Road show, skit play, one-act play
9. Participation in One-Act-Play - Participation in Purushottam karandam, Firodia karandak, Dajikaka Gadgil Karandak and Shreetej Karandak.
10. Marathi Film Review – Watch the Marathi movie widely available on an OTT (Over-The-Top) platform , broadcaster in Television or availle on YouTube and write a review.

Savitribai Phule Pune University Second Year of Computer Science and Engineering(Data Science) (2024 Course)		
EEM-283-CDS- Technology Commercialization and Startup		
Teaching /scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week **Tutorial** : 01 Hours/Week	02	**Term Work :** 25 Marks

Course Objectives: The course aims to:

1. Importance of technology commercialization and startup.
2. Intellectual property rights for protecting invention with product ownership.
3. Requisite knowledge of Registration process of for startup.
4. Setup of cost & funding for startup.
5. Go-to-Market (GTM) strategy for business venture.

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

- CO1: **Apply** the concepts of the technology commercialization for starting a new venture.
- CO2: **Register** invention to protect the invention through IPR.
- CO3: **Discuss** the registration process with requisite market knowledge, skills and right attitude.
- CO4: **Create** the costing sheet by identifying the available funding resources.
- CO5: **Implement** Go-to-Market strategy for a business venture.

Course Contents

Unit I - Introduction to Technology commercialization & Startup ecosystem

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.
Exemplars/Case Studies : Electric car, Pharma company, Joint venture, Agriculture

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

Unit II - Unit-2: IPR & Legal compliance

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

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

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

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%20Kit_Digital_Jan19.pdf
9. Fundamentals of Intellectual Property Rights by Anil Kumar H S and B. Ramakrishna.
10. Philip Kotler, Kevin Lane Keller, Marketing Management – Pearson Education, 16e, 2022,ISBN 9356062668

E-Books Links: -

1. Technology Laws Decoded Author N.S.Nappinai
2. IPR-eng-ebook by bharatidasan University
3. Fundamentals Of Intellectual Property Rights And Patents by Rashika Kapadiya.
4. Peter Thiel, Blake Masters ,Zero to One: Notes on Startups, or How to Build the Future Crown Publishing Group,2014, 978-0-8041-3930-4
5. https://dst.gov.in/sites/default/files/E-BOOK%20IPR.pdf

Links to online SWAYAM/NPTEL Courses:-

1. Innovation Business Model and Entrepreneurshipby prof.Rajat Agrawal,Prof.Vinay Sharma I2IT Rookee.
2. Innovation and Start-up Policy By Prof. Rahul K. Mishra IILM Institute for Higher Education
3. https://onlinecourses.swayam2.ac.in/imb20_mg22/preview
4. Innovation, Business Models and Entrepreneurship, By Prof . Rajat Agrawal and Prof. Vinay Sharma | IIT Roorkee
5. https://onlinecourses.nptel.ac.in/noc19_mg55/preview
6. https://onlinecourses.nptel.ac.in/noc22_hs59/preview
7. Innovation Driven Entrepreneurship https://onlinecourses.swayam2.ac.in/ntr24_ed05/preview

YouTube/Video Links:

1. https://www.youtube.com/watch?v=7BfdMKeLTj0
2. https://www.youtube.com/watch?v=zkWJAvg6_ME
3. https://www.youtube.com/watch?v=rqi-n0hA4uo
4. https://www.youtube.com/watch?v=F4YuptMRMBY
5. https://www.youtube.com/watch?v=6lY9CYIY4pQ
6. https://www.youtube.com/watch?v=zwQ8TNkcYzc
7. https://www.youtube.com/watch?v=NP2pXTdyEGc

Savitribai Phule Pune University Second Year of Computer Science and Engineering - (Data Science) (2024 Course)		
VEC-284- CDS - Environmental Studies		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week	02	**CCE :** 15 Marks **End-Sem Examination :** 35 Marks

Course Objectives: The course aims to:

1. To introduce the multidisciplinary nature and scope of environmental studies.
2. To understand ecosystem structures, biodiversity, and ecological balance through hands-on observation and documentation.
3. To examine the use and impact of natural resources on environmental sustainability.
4. To explore biodiversity conservation practices and develop eco-sensitive thinking through field-based inquiry.

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

- CO1. **Illustrate** the interdependence of ecosystems through activity-based exploration
- CO2. **Analyze** the role of natural resources in sustainable development using real-world data.
- CO3. **Investigate** biodiversity threats and conservation strategies through surveys and projects
- CO4. **Create** awareness tools or **reports** promoting sustainability based on their findings.

Course Contents

Unit I - Environment and its issues (07 Hours)

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

Unit III - Environment Pollution (07 Hours)

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

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

E- waste; composition and generation. Global context in e- waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E- waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E waste management, Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials-mechanical processing, technologies for recovery of materials, occupational and environmental health perspectives of recycling e-waste in India.

Unit IV - E-waste Control and measures

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

Practical Assignments

Week	Topic to be covered

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

Learning Resources

Text Books:

1. Odum, Eugene P. “Fundamentals of Ecology”
2. R. Rajagopalan, “Environmental Studies – From Crisis to Cure”, Oxford
3. Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi

Reference Books:

1. Erach Bharucha, “Textbook of Environmental Studies”, UGC
2. Anubha Kaushik and C.P. Kaushik, “Environmental Studies”, New Age International

E-Books Links: -

1. https://www.environment.gov.in
2. https://www.unep.org
3. https://news.mit.edu/2013/ewaste-mit

Savitribai Phule Pune University, Pune

Maharashtra, India

Task Force for Curriculum Design and Development

Programme Coordinator

Dr. Vaishali P. Vikhe - Member - Board of Studies - Computer Engineering

Team Members for Course Design

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Mr. Mayur Saitwal	Industry Representative

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Mr. Rokade S. M	Sir Visvesvaraya Institute of Technology, Nashik
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Dr. Anand Khatri	Jayhind College of Engg, Junnar

Dr. Anand Gharu	MET Engg. College, Nashik

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Prof. Prasad A Lahare	College of Engineering & SS Dhamankar Institute of Management, Nashik
Dr. Minakshi P Atre	PVG'S College Of Engineering and Technology Pune
Mr. Vikram K Abhang	Amrutvahini College of Engineering, Sangamner
Mr. Satyajit S Nimbalkar	SVPM's College of Engineering in Malegaon, Baramati
Dr. Deepankar Roy	National Institute of Bank Management, Pune

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Mr. Shubham D Shelke	Samarth College of Engineering and Management, Belhe
Mr. Pankaj B Devre	MIT Academy of Engineering ,Alandi, Pune
Mr. Sachin S. Bhanwase	ShivMani InfoTech Pvt.Ltd.,Pune

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Mr. Sharad Ramdas Kale	Shoption Private Limited

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Dr. Sharayu A. Lokhande	Army Institute of Technology, Pune
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Mr. Sagar Shinde	MES, Wadia College of Engineering, Pune
Mr. Manoj Kharde	Pravara Rural Engineering College, Loni
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Dr. Swapnil Bachhav	MVP Adv. Baburao Ganpatrao Thakare College of Engineering MBA Department, Nashik

Internet of Things	
Dr. Yogita Sinkar	Shivnagar Vidya Prasarak Mandal's College of Engineering Malegoan. Baramati
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Mrs.Shubhangi W Halkunde	MET's Institute of Engineering Nashik
Prof. Pradip P Ghorpade	VP's Kamalnayan Bajaj Institute of Engineering & Technology, Baramati
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Dean

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Savitribai Phule Pune University, Pune

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