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

(With effect from Academic Year 2025-26)

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Nomenclature

AEC Ability Enhancement Course

AICTE All India Council for Technical Education

CCE Comprehensive Continuous Evaluation

CEP Community Engagement Project

EEM Entrepreneurship Management

ESE End-Semester Examination

MDM Multidisciplinary Minor

MOOC Massive Open Online Course

NEP National Educational Policy

NPTEL National Programme on Technology Enhanced Learning

OE Open Elective

PCC Program Core Course

PEO Programme Educational Objectives

PSO Program Specific Outcomes

SWAYAM Study Webs of Active-Learning for Young Aspiring Minds\\

VEC Value Education Course

VSE Vocational and Skill Enhancement Course

WK Knowledge and Attitude Profile

Preface by Board of Studies

Dear Students and Teachers,

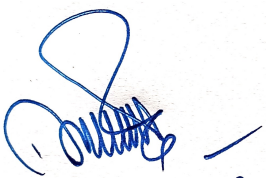
We, the members of Board of Studies Computer Science, are very happy to present Second Year Computer Science syllabus effective from the Academic Year 2025-26. The present curriculum will be implemented for Second Year of Engineering from the academic year 2025-26. Subsequently this will be carried forward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

Computer Science is a dynamic discipline that lies at the intersection of electrical engineering and computer science. It provides the foundation for the design, development, and application of computer systems and other computing devices. This curriculum is designed to provide students with a comprehensive understanding of the fundamental principles, theories, and practices of Computer Science, while also preparing them for the ever-evolving technological landscape.

The revised syllabus falls in line with the objectives of NEP-2020, Savitribai Phule Pune University, AICTE New Delhi, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.Wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided at the end of each course. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

This curriculum is the result of extensive consultation with academic experts, industry professionals, and alumni to ensure relevance and excellence. 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 Science.

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

Members of Board of Studies - Computer Science	
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Program Specific Outcomes (PSO)

- **PSO1:** Professional Skills-The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based systems of varying complexities.
- **PSO2:** Problem-Solving Skills- The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.
- **PSO3:** Successful Career and Entrepreneurship- The ability to employ modern computer languages, environments and platforms in creating innovative career paths to be an entrepreneur and to have a zest for higher studies.

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.

Reference: Self-Assessment Report (SAR) Format Undergraduate Engineering Programs Graduate Attributes and Professional Competencies Version 4.0 (GAPCV4.0) - (August 2024) Page 55.

Programme Outcomes (PO)

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

PO1	Engineering knowledge	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO2	Problem analysis	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3	Design / Development of Solutions	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO4	Conduct Investigations of Complex Problems	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO5	Engineering Tool Usage	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO6	The Engineer and The World	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	Individual and Collaborative Team work	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	Communication	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	Life-Long Learning	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

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

General Rules and Guidelines

- Course Outcomes (CO): Course Outcomes are narrower statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.
- Assessment: Assessment is one or more processes, carried out by the institution, that identify, collect, and prepare data to evaluate the achievement of Program Educational Objectives and Program Outcomes.
- Evaluation: Evaluation is one or more processes, done by the Evaluation Team, for interpreting the data and evidence accumulated through assessment practices. Evaluation determines the extent to which Program Educational Objectives or Program Outcomes are being achieved, and results in decisions and actions to improve the program

Guidelines for Examination Scheme

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

Comprehensive Continuous Evaluation (CCE) :

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

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

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

Sr.	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 Study	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 Uit): 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

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-CSC	Program Core Course	Data Structures	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-202-CSC	Program Core Course	Operating Systems	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-203-CSC	Program Core Course	Discrete Mathematics	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-204-CSC	Program Core Course	Data Structures Laboratory	-	-	4	-	-	25	50	-	75	-	-	2	2
PCC-205-CSC	Program Core Course	Operating Systems Laboratory	-	-	2	-	-	25	-	25	50	-	-	1	1
	Open Elective	*Open Elective - I	2	-	-	15	35	-	-	-	50	2	-	-	2
MDM-221- CSC	Multidisciplinary Minor	Digital Electronics and Logic Design	2	-	-	30	70	-	-	-	100	2	-	-	2
EEM-231-CSC	Entrepreneurship Management	Entrepreneurship Development	-	1	2	-	-	25	-	-	25	-	1	1	2
VEC-232-CSC	Value Education	Universal Human Values and Professional Ethics	2	-	-	15	35	-	-	-	50	2	-	-	2
CEF-241-CSC	Community Engagement Project	Community Engagement Project	-	-	4	-	-	25	-	25	50	-	-	2	2
Total			**15**	**1**	**12**	**150**	**350**	**100**	**50**	**50**	**700**	**15**	**1**	**6**	**22**

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

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

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-CSC	Program Core Course	Database Management systems	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-252-CSC	Program Core Course	Advanced Data Structures	3	-	-	30	70	-	-	-	100	3	-	-	3
PCC-253-CSC	Program Core Course	Probability and Statistics	2	-	-	30	70	-	-	-	100	2	-	-	2
PCC-254-CSC	Program Core Course	Database Management systems Laboratory	-	-	2	-	-	-	25	-	25	-	-	1	1
PCC-255-CSC	Program Core Course	Advanced Data Structures Laboratory	-	-	2	-	-	25	-	25	50	-	-	1	1
	Open Elective	*Open Elective - II	2	-	-	15	35	-	-	-	50	2	-	-	2
MDM-271- CSC	Multidisciplinary Minor	Internet of Things	2	-	-	30	70	-	-	-	100	2	-	-	2
VSE- 281-CSC	Vocational and Skill Enhancement Course	Object Oriented Programming in Java	-	-	4	-	-	25	25	-	50	-	-	2	2
AEC-282-CSC	Ability Enhancement Course	Modern Indian Language (Marathi)	-	1	2	-	-	50	-	-	50	-	1	1	2
EEM-283-CSC	Entrepreneurship / Economics / Management	Intellectual Property Rights	-	1	2	-	-	25	-	-	25	-	1	1	2
VEC-284-CSC	Value Education Course	Environmental Studies	2	-	-	15	35	-	-	-	50	2	-	-	2
Total			**14**	**2**	**12**	**150**	**350**	**125**	**50**	**25**	**700**	**14**	**2**	**6**	**22**

*** 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.
- Example - Open Elective II - Business and 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

2024 Pattern

Semester III

With effect from Academic Year 2025-26

Savitribai Phule Pune University Second Year of Computer Science (2024 Course)		
PCC-201-CSC: Data Structures		
Teaching scheme	**Credits**	**Examination Scheme**
Theory : 03Hours/Week	03	CCE : 30 Marks End-Semester: 70 Marks

Prerequisite Courses, if any :

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

Companion Course : Data Structures Laboratory (PCC-204-CSC)

Course Objectives: The course aims:

1. To understand the basic techniques of algorithm analysis.
2. To acquaint with the structural constraints and advantages in usage of the data.
3. To understand various data structures, operations on data structures and the memory requirements of it.
4. To understand various data searching and sorting methods with pros and cons.
5. To provide the practical implementation and usage of data structures as a solution to real world problems.

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

1. CO1: **Design** the algorithms to solve the programming problems, identify appropriate algorithmic strategies for specific applications, and analyze the time and space complexity.
2. CO2: **Demonstrate** the use of sequential data structures like arrays and linked lists to store and process data.
3. CO3: **Understand** the fundamental principles behind various search and sort algorithms, **analyze** their time and space complexities, **choose** the most appropriate algorithm for a given problem based on data characteristics and effectively **implement** these algorithms in code.
4. CO4: **Demonstrate** the understanding of stack data structures, their memory representation, and applications in function calls, expression evaluation, and balancing parentheses.
5. CO5: **Understand** and **implement** a queue as a linear data structure to solve real-world problems.

Course Contents

Unit I - Introduction to Algorithm and Data Structure (09 Hours)

Introduction to Basic Concepts: Data, Information, Knowledge , Data Structure, Abstract Data Types (ADT), Data Structure Classification

Algorithms: Problem Solving, Introduction to Algorithm, Characteristics of Algorithm

Complexity of Algorithm: Space complexity, Time complexity, Asymptotic notation-Big-O, Theta and Omega, Finding complexity using step count method, Analysis of programming constructs-Linear, Quadratic, Cubic, Logarithmic

Case Study: Social Network Recommendation System, Search Engine Auto-complete

Reference Books: T1, T2, R4

***Mapping of Course Outcomes for Unit I:** CO1

Unit II - Array and Linked List (09 Hours)

Array: Basics of Array, Storage Representation and their Address Calculation: Row Major and Column Major.

Types of Arrays: 1 Dimensional, Multi-Dimensional (2D, 3D), Array Operations,

Sparse Array & Compressed Storage: Representation, Addition and Transpose, Array as an ADT, Pros & Cons of an Array.

Linked List: Basics of Linked List, **Linked List Operation:** Create, Insert, Delete, Search, Types of Linked List: Singly Linked List (SLL), Doubly Linked List (DLL), Circular Linked List (CLL), Generalized **Linked List (GLL):** Representation of polynomial using GLL, Pros & Cons of Linked List.

Case Study : Analyze and implement a playlist manager using both an Array and a Linked List. Compare their performance based on different operations.

Reference Books: T1, T2, R2,R5

***Mapping of Course Outcomes for Unit II:** CO2

Unit III - Searching and Sorting (09 Hours)

Searching: Sequential Search, Variations on Sequential Searches, Sentinel Linear Search, Fibonacci Search, Binary Search Algorithm – Iterative and Recursive Implementation.

Sorting: Insertion sort, Selection Sort, Bubble Sort, Merge Sort, Heap Sort, Quick Sort, 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 Uni-modal Functions.

Reference Books: T1, R1, R2

***Mapping of Course Outcomes for Unit III:** CO1,CO3

Unit IV - Stack (09 Hours)

Basic Concepts: Definition, Operations. Stack as an ADT, Memory Representation: Using Array, Using Linked List.

Memory Management: Stack Memory Vs Heap Memory, How function calls are managed using stacks, Stack Overflow: Causes & Prevention. Applications of Stack: Expression of Evaluation & Conversion

Case study : Implementation and Comparison of Stack Using Array and Linked List

Reference Books: T1, T2, R5

***Mapping of Course Outcomes for Unit IV:** CO4

Unit V - Queue (09 Hours)

Queue: Basic Concepts, Queues as ADT, Queue Representation using sequential organization, Queue operations , Implementation of queue using array and linked organization,

Types of Queue: Circular Queue and its advantages, Double ended Queue (Deque) and its types (Input restricted and Output restricted), Priority Queue: basic concept and its types (Ascending and descending), Real time applications of queues.

Case study: Bank's customer service system

Reference Books: T1, T2, R5

***Mapping of Course Outcomes for Unit V:** CO5

Learning Resources

Text Books:

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

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. R.Gillberg, B.Forouzan—Data Structures: A Pseudocode approach with C, Cengage Learning, ISBN: 9788131503140.

2. M.Weiss—Data Structures and Algorithm Analysis in C++, 2nd edition, Pearson Education, 2002, ISBN-81- 7808-670-0.

3. Horowitz, Sahani —Fundamentals of Data Structures, Galgotia Book source.

4. “Introduction to Algorithms” by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein

5. Data Structures and Algorithms Made Easy in C++ Narasimha Karumanchi.

e-Books: -

1. https://www.ebooks.com/en-us/book/95777110/Python-data-structures-and-algorithms/benjamin-baka/

2. https://www.ebookphp.com/advanced-data-structures-epub-pdf/

3. https://www.ebookphp.com/data-structures-and-algorithms-professional-edition-beginners-guide-epub-pdf

MOOC / NPTEL/YouTube Links: -

1. https://nptel.ac.in/courses/106/102/106102064/

2. https://nptel.ac.in/courses/106/105/106105085

3. https://nptel.ac.in/courses/106/106/10610612

Savitribai Phule Pune University Second Year of Computer Science (2024 Course)		
PCC-202-CSC: Operating Systems		
Teaching scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 30 Marks **End-Semester :** 70 Marks

Prerequisite Courses :

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

Companion Course : Operating Systems Laboratory (PCC-205-CSC)

Course Objectives: The course aims to:

1. To learn the basic concepts of Operating systems and its services
2. To acquire knowledge of process and threads along with scheduling algorithms
3. To study how the interprocess communication and synchronizations happens
4. To learn how memory management is handled in operating systems
5. To study different I/O devices, its management and disk processing.

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

1. CO1: **Understand** the structure of OS and basic architectural components involved in OS design.
2. CO2: **Understand** the requirements for the process synchronization and threads.
3. CO3: **Understand** and **analyze** inter-process communication and synchronization.
4. CO4: **Analyze** various algorithms for memory management of operating systems.
5. CO5: **Understand** various I/O device structures and analyze scheduling algorithms.

Course Contents

Unit I - Fundamentals of Operating Systems (09 Hours)

Basics of Operating Systems: Introduction, Operating system operations, Generations, Types of OS various computing environments, Operating System Structure - Open Source Operating Systems. , O.S. Services, Types of System Calls, System Boot, System Programs, Protection and Security, Distributed & Real Time O.S.

Reference Books: R1, T1

***Mapping of Course Outcomes for Unit I:** CO1

Unit II - Process and Threads Management (09 Hours)

Process: Process Concept, Process Creation and Termination, Process Scheduling, Process Synchronization,

Threads: Thread Concept, Thread Creation and Management, Thread Synchronization, Multicore Programming, Operating System Support for Threads

Reference Books: R1, R2, T1

***Mapping of Course Outcomes for Unit II:** CO2, CO3

Unit III - Inter Process Communication and Synchronization (09 Hours)

Interprocess Communication: Shared-Memory Systems, Message-Passing Systems
Synchronization: Critical-section, Hardware approach, Software approach, Reader writer problem, producer Consumer problem, Dining Philosopher problem Deadlocks: Principle of deadlock, Deadlock prevention, deadlock avoidance, deadlock detection, deadlock recovery.

Reference Books: R2, T1 ,T2

***Mapping of Course Outcomes for Unit III** :CO2, CO3

Unit IV- Memory Management (09 Hours)

Basic concept, Logical and Physical address maps, Memory allocation: Contiguous Memory allocation – Fixed and variable partition–Internal and External fragmentation and Compaction.
Basics of Virtual Memory: Locality Of reference, Page allocation, Partitioning, Paging, Page fault, Working Set, Segmentation, Demand paging
Page Replacement algorithms: Optimal, First in First Out (FIFO), Not Recently used (NRU) and Least Recently used (LRU).

Reference Books: R2, T1 ,T2

***Mapping of Course Outcomes for Unit IV:** CO4

Unit V- I/O Management & Disk scheduling (09 Hours)

I/O Devices, I/O Hardware, Organization of I/O functions, Operating System Design issues, I/O Buffering,
Disk Scheduling algorithms: FCFS, SCAN, C-SCAN, SSTF , performance issues.

Reference Books: R2, T1 ,T2

***Mapping of Course Outcomes for Unit:** V CO5

Learning Resources

Text Books:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne (2006), Operating System Principles, 9th edition, Wiley India Private Limited
2. Dhananjay Dhamdhere , OPERATING SYSTEMS: A CONCEPT-BASED APPROACH , McGraw-Hill, ISBN 978–0–07–295769–3

Reference Books:

1. Stallings (2006), Operating Systems, Internals and Design Principles, 5th edition, Pearson Education, India.
2. Andrew S. Tanenbaum (2007), Modern Operating Systems, 2nd edition, Prentice Hall of India, India.
3. Deitel & Deitel (2008), Operating systems, 3rd edition, Pearson Education, India.

MOOC / NPTEL/YouTube Links: -

1. https://onlinecourses.swayam2.ac.in/nou25_cs11/preview, Fundamentals of Operating system
2. https://onlinecourses.swayam2.ac.in/ntr25_ed41/preview, Operating Systems
3. https://onlinecourses.swayam2.ac.in/aic20_sp24/preview, Linux Operating System
4. https://www.youtube.com/watch?v=dOiA2nNJpc0, Introduction to Operating system.

5. https://www.youtube.com/watch?v=yK1uBHPdp30, Operating Systems for Beginners

E-Books :

1. https://www.freebookcentre.net/ComputerScience-Books-Download/Operating-Systems-An-introduction-to-Unix,-and-Operating-Systems-Theory.html, Operating Systems An introduction to Unix, and Operating Systems Theory
2. https://www.scs.stanford.edu/12au-cs140/notes/ , Operating Systems Lecture Notes by Stanford University

Savitribai Phule Pune University Second Year of Computer Science (2024 Course)		
PCC-203-CSC: Discrete Mathematics		
Teaching scheme	**Credits**	**Examination Scheme**
Theory : 03Hours/Week	03	**CCE** : 30 Marks **End-Semester**: 70 Marks

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

1. Basic Mathematics

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. To introduce students to understand, explain, and apply the foundational mathematical concepts at the core of computer science.
2. To understand use of set, function and relation models to understand practical examples, and interpret the associated operations and terminologies in context.
3. To acquire knowledge of logic and proof techniques to expand mathematical maturity.
4. To learn the fundamental counting principle, permutations, and combinations.
5. To study how to model problems using graphs and trees.
6. To learn algebraic structures

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

- CO1: **Apply** and **Analyze** Set Theory and Propositional Logic
- CO2: **Evaluate** and **Construct** Models using Relations and Functions
- CO3: **Design** and **Implement** Tree Structures and Network Flow Algorithms
- CO4: **Analyze** and **Develop** Solutions using Graph Theory
- CO5: **Apply** and **Solve** Problems using Counting Principles, **Understand** Algebraic

Course Contents

Unit I - Set and Propositions (09 Hours)

Introduction and significance of Discrete Mathematics, Propositional Logic-: logic, Propositional Equivalences, Application of Propositional Logic- Translating English Sentences, Proof by Mathematical Induction and Strong Mathematical Induction.

Sets: Naive Set Theory (Cantorian Set Theory), Axiomatic Set Theory, Set Operations, Cardinality of set, Principle of inclusion and exclusion. Types of Sets – Bounded and Unbounded Sets, Diagonalization Argument, Countable and Uncountable Sets, Finite and Infinite Sets, Countably Infinite and Uncountably Infinite Sets, Power set.

Case study: Know about the great philosophers- Georg Cantor, Richard Dedekind and Aristotle. Design a recommendation system using logical propositions and predicates to filter movies based on user preferences.

Reference Books: T1, R1

***Mapping of Course Outcomes for Unit I:** CO1

Unit II - Relations and Functions (09 Hours)

Introduction to Relations and their Properties Representation of Relations using Matrices and Digraphs Equivalence relations, Partial orderings, Partitions, Hasse diagram, Lattices, Chains and Anti-Chains, Transitive closure and Warshall's algorithm.

Functions: Types of Functions (Injective, Surjective, Bijective) , Composition and Inverse of Functions , Recursive Functions and Applications in Algorithms , Counting Functions and Growth of Functions.

Cast Study: Know about the great philosophers-Dirichlet

Reference Books: T1, R2, R6

***Mapping of Course Outcomes for Unit II:** CO2

Unit III - Trees (09 Hours)

Introduction to Trees and Properties ,Binary Trees and Binary Search Trees (BST) ,Tree Traversal Techniques: Preorder, Inorder, Postorder , Huffman Trees and Data Compression Algorithms ,Decision Trees and their Applications in Machine Learning , Applications of Trees in File Systems, The Max flow- Min Cut Theorem in Transport network.

Case Studies - Algebraic Expression Tree, Tic-Tac-Toe Game Tree, implement a file directory system using a tree structure, allowing hierarchical organization of files and folders

Reference Books: T1, R1 ,R5

***Mapping of Course Outcomes for Unit III:** CO3

Unit IV - Graph Theory (09 Hours)

Introduction to Graphs: Types and Representation ,Graph Traversals: BFS and DFS ,Connected Components and Path finding Algorithms, Eulerian and Hamiltonian Paths and Circuits , Planar Graphs and Graph Coloring, Dijkstra's Algorithm for Shortest Paths , Spanning Trees and Minimum Spanning Tree Algorithms (Prim's and Kruskal's)

Case study : Model a social media platform using directed graphs to represent relationships such as "follower" or "friend." Three utility problem, Web Graph, Google map

Reference Books: R3 , R4

***Mapping of Course Outcomes for Unit IV:** CO4

Unit V - Counting Principles and Algebraic Structures - (09 Hours)

Basic Counting Techniques: Addition and Multiplication Principles , Permutations and Combinations, Binomial Coefficients and Pascal's Triangle, Pigeonhole Principle and its Applications , Inclusion-Exclusion Principle, Generating Functions for Counting Problems.

The structure of algebra, Algebraic Systems, Semi Groups, Monoids, Groups, Homomorphism and Normal Subgroups and Congruence relations, Rings, Integral Domains and Fields.

Case Studies - Study Sudoku solving algorithms and algorithm for generation of new SUDOKU. Study Hank-shake Puzzle and algorithm to solve it Calculate the number of possible password combinations given specific constraints on length, character types, and repetition.

Reference Books: T1 , R1 , R6

***Mapping of Course Outcomes for Unit V:** CO5

Learning Resources

Text Books:

1. C. L. Liu, "Elements of Discrete Mathematics"||, TMH, ISBN 10:0-07-066913-9.
2. N. Biggs, "Discrete Mathematics", 3rd Ed, Oxford University Press, ISBN 0 –19-850717–8.

Reference Books:

1. Kenneth H. Rosen, “Discrete Mathematics and its Applications”||, Tata McGraw-Hill, ISBN 978-0-07-288008-3

2. Bernard Kolman, Robert C. Busby and Sharon Ross, “Discrete Mathematical Structures”||, Prentice-Hall of India /Pearson, ISBN: 0132078457, 9780132078450.

3. Narsingh Deo, “Graph with application to Engineering and Computer Science”, Prentice Hall of India, 1990, 0 – 87692 – 145 – 4.

4. Eric Gossett, “Discrete Mathematical Structures with Proofs”, Wiley India Ltd, ISBN:978-81-265-2758-8.

5. Sriram P.and Steven S., “Computational Discrete Mathematics”, Cambridge University Press, ISBN 13: 978-0-521-73311-3.

6. Herstein, I. N. Topics in Algebra. 2nd ed., Indian Adaptation, Wiley India Pvt. Ltd., 2006. ISBN: 9788126510184.

E-Books:

1. https://www.ebookphp.com/discrete-mathematical-structures-6th-edition-epub-pdf/

2. http://discrete.openmathbooks.org/pdfs/dmoi-tablet.pdf

3. http://home.iitk.ac.in/∼arlal/book/mth202.pdf

4. https://web.stanford.edu/class/cs103x/cs103x-notes.pdf

5. http://home.iitk.ac.in/∼arlal/book/mth202.pdf

MOOC/NPTEL/SWAYAM/YouTube Course Links:

1. https://archive.nptel.ac.in/courses/111/106/111106086/

2. https://onlinecourses.nptel.ac.in/noc20_cs82/preview

Savitribai Phule Pune University Second Year of Computer science (2024 Course)		
PCC-204-CSC: Data Structures Laboratory		
Teaching scheme	**Credits**	**Examination Scheme**
Practical : 04 Hours/Week	**Practical**: 02	**Term Work** : 25 Marks **Practical :** 50 Marks

Prerequisites Courses:

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

Companion Course: Data Structure (PCC-201-CSC)

Course Objectives: To understand basic techniques and strategies of algorithm analysis, the memory requirement for various data structures like array, linked list, stack, queue etc using concepts of python, C and C++ programming languages.

Course Outcomes:

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

1. CO1: **Use** algorithms on various linear data structures using sequential organization to solve real life problems.
2. CO2: **Analyze** problems to apply suitable searching and sorting algorithms to various applications.
3. CO3: **Analyze** problems to use variants of linked lists and solve various real life problems.
4. CO4: **Design** and **implement** data structures and algorithms for solving different kinds of problems.

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 Python, C, C++

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.

Sr	List of Laboratory Experiments/Assignments (Any 10 from the given list)
1	Develop a C / C++ / Python program : a)To display your name, count the length of it and display what your age will be in a year. b)To calculate an arithmetic operation using type conversion
2	Develop a C / C++ / Python program to read the student details like name, USN and marks in 5 subjects. Display the student details, total marks and percentage with suitable messages.
3	Develop a C / C++ / Python program to input the names and prices of n grocery items (where n is entered by the user). Also Calculate the total bill and apply a discount: If total>1000, apply 10% discount Otherwise, no discount. Display final bill after discount.
4	Write a C / C++ / Python program to implement the following problem statement. In Music Class, group A students play Harmonium, group B students play Tabla and group C students play Guitar. a)List of students who play both Harmonium and Tabla. b)List of students who play either Harmonium or Tabla but not both. c)Number of students who play neither Harmonium nor Tabla. d)Number of students who play Harmonium and Guitar but not Tabla.
5	Write a C / C++ / Python program to implement a Singly Linked List (SLL) that supports the following operations: a)Insertion: Add a new node at the beginning, end or at a specific position. b)Deletion: Remove a node from the beginning, end or from a specific position. c)Search: Find an element in the linked list. d)Display: Print all elements in the linked list.

6	Design C / C++ / Python program to implement a circular doubly linked list that represents a music playlist. Each node contains the song name and duration. The playlist should support the following operations: a)Add a new song to the playlist b)Play the next song (move to the next node) c)Play the previous song (if using a circular doubly linked list) d)Display the current playlist in order e)Loopback to the first song after the last song
7	Write a C / C++ / Python program to store names and mobile numbers of your friends in sorted order on names. Search your friend from the list using Binary Search (recursive and non-recursive). Insert friend if not present in phonebook.
8	In a university, student scores (out of 100) from a programming exam are collected. The scores are floating-point numbers (e.g., 85.5, 92.0, 67.25). The university wants to efficiently sort these scores to publish a ranked list. Write a C / C++ / Python program to sort an array of floating-point student scores in ascending order using the Quick Sort algorithm.
9	Implement a menu driven program in C / C++ / Python for the following operations on Stack of Integers (Array Implementation of Stack with maximum size MAX) a)Push an Element on to Stack b)Pop an Element from Stack c)Demonstrate how Stack can be used to check Palindrome d)Demonstrate Overflow and Under flows situations on Stack e)Display the status of Stack f)Exit
10	Write a C / C++ / Python program that accepts an Infix expression as a string, Converts it to Postfix notation using a stack. Display the converted expression.
11	Queues are frequently used in computer programming and a typical example is the creation of a job queue by an operating system. If the operating system does not use priorities, then the jobs are processed in the order they enter the system. Write a C / C++ / Python program for simulating job queue. Write functions to add jobs and delete jobs from the queue.
12	Write a C / C++ / Python program to implement a priority queue for managing Emergency Room patients. The program should support the following operations: a)Add a new patient (with name, age, and priority). b)Serve the next patient (based on highest priority and arrival order). c)Display the current queue (in order of treatment). d)Exit the system.

Learning Resources

Text Books:

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

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. R.Gillberg, B.Forouzan—Data Structures: A Pseudocode approach with C, Cengage Learning, ISBN: 9788131503140.

2. M.Weiss—Data Structures and Algorithm Analysis in C++, 2nd edition, Pearson Education, 2002, ISBN-81- 7808-670-0.

3. Horowitz, Sahani —Fundamentals of Data Structures, Galgotia Book source.

4. “Introduction to Algorithms” by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein

5. Data Structures and Algorithms Made Easy in C++ Narasimha Karumanchi.

Virtual Lab Links: -

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

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

Savitribai Phule Pune University Second Year of Computer science (2024 Course)		
PCC-205-CSC: Operating Systems Laboratory		
Teaching scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	**Practical**: 01	**Term Work** : 25 Marks **Oral :** 25 Marks

Prerequisites Courses:

1. Fundamentals of Programming Languages (ESC-105-COM)
2. Introduction to Operating system (PCC-202-CSC)

Companion Course: Introduction to Operating Systems (PCC-202-CSC)

Course Objectives:

1. To understand the basic concepts of Operating systems using Unix/Linux system calls, Shell scripting and awk programming.

Course Outcomes:

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

1. CO1: To **study** different Unix Commands.
2. CO2: To **learn** and implement the basic system calls of Operating systems.
3. CO3: To **apply** shell scripts and algorithms for programming applications.
4. CO4: To **learn** awk programming.

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.

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 Python, Programming tools like Jupyter Notebook, Pycharm, Spyder, 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.

Sr	List of Laboratory Experiments/Assignments (Any 8 from the given list)
1	Study of Basic commands of Linux/UNIX.
2	Study of Advance commands and filters of Linux/UNIX.
3	Write a shell script to generate a mark sheet of a student. Take 3 subjects, calculate and display total marks, percentage and Class obtained by the student.
4	Write a shell script to display multiplication table of given number
5	Write a shell script to find the factorial of given number n.
6	Write a shell script which will accept a number b and display first n prime numbers as output.
7	Write a shell script which will generate first n Fibonacci numbers like: 1, 1, 2, 3, 5, 13, ...
8	Write a menu driven shell script which will print the following menu and execute the given task. a)Display calendar of current month b)Display today's date and time c)Display usernames those are currently logged in the system d)Display your name at given x, y position e)Display your terminal number
9	Write a shell script to read n numbers as command arguments and sort them in descending order.
10	Write a shell script to display all executable files, directories and zero sized files from the current directory.
11	Write a shell script to check if the entered string is palindrome or not.
12	Shell programming using filters (including grep, egrep, fgrep)
13	Study of Unix Shell and Environment Variables.
14	Write a shell script to validate the entered date. (eg. Date format is : dd-mm-yyyy).

15	Write an awk program using a function which converts each word in a given text into capital.
16	Write a program for process creation using C. (Use of gcc compiler).

Learning Resources

Virtual Lab Links: -

1. https://naim30.github.io/OS-virtual-lab/
2. https://profile.iiita.ac.in/bibhas.ghoshal/teaching_os_lab.html

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

Prerequisite Courses, if any :

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

Course Objectives:

1. To learn and understand basic digital design techniques.
2. To learn and understand design and construction of combinational and sequential circuit
3. To understand and verify simulated circuits with hardware implementation.
4. To understand the functionalities, properties and applicability of Logic devices.

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

1. CO1: **Apply** knowledge of Logic Minimization Techniques to reduce the complexity of Digital circuits.
2. CO2: **Design** and **implement** combinational circuits.
3. CO3: **Design** and **implement** sequential circuits.
4. CO4: **Design** and **develop** effective HDL code for digital circuits.
5. CO5: **Apply** different modeling techniques to develop VHDL code for specific Application design.

Course Contents

Unit I - Introduction to Digital Systems (06 Hours)

Binary Number System: Representation and conversions (decimal, binary, octal, hexadecimal).
Logic Levels and Gates: Introduction to digital signals, basic logic gates (AND, OR, NOT, NAND, NOR, XOR).
Boolean Algebra: Boolean expressions, laws and theorems, simplification (K-map, Quine-McCluskey method)
Case Studies: Design of any real time application using k-Map as a minimization technique.
Reference Books:

1. M. Morris Mano, "Digital Design," Pearson.
2. John F. Wakerly, "Digital Design: Principles and Practices," Pearson.

***Mapping of Course Outcomes for Unit I:** CO1

Unit II - Combinational Logic Circuits (06 Hours)

Introduction to Combinational Circuits: Concept and examples. Design and Implementation: Adders (Half Adder, Full Adder), Subtractors, Multiplexers, Demultiplexers, Encoders, Decoders.
Applications: Arithmetic circuits, data routing, and logical operations in digital systems.
Case Studies: Combinational Logic Design of BCD to 7-segment display Controller
Reference Books:

1. M. Morris Mano, "Digital Design," Pearson.
2. John F. Wakerly, "Digital Design: Principles and Practices," Pearson.

***Mapping of Course Outcomes for Unit II:** CO2

Unit III - Sequential Logic Circuits (06 Hours)

Basics of Flip-Flops: SR, JK, D, T. Design and Analysis of Sequential Circuits. Fundamental Concepts: Latch vs Flip-Flop.Sequential Circuit Design: Counters (Asynchronous and Synchronous), Registers, State Machine: Moore and Mealy Models. Analysis and Design: State diagrams, state tables, and timing diagrams

Case Studies: Design of vending machines.

Reference Books:

1. M. Morris Mano, "Digital Design," Pearson.
2. John F. Wakerly, "Digital Design: Principles and Practices," Pearson.

***Mapping of Course Outcomes for Unit III:** CO3

Unit IV - Digital System Design (06 Hours)

Introduction to Hardware Description Languages (VHDL/Verilog). Design Flow, Language constructs, Data objects, Data types, Entity, Architecture & types of modeling, Sequential statements, Concurrent statements, Packages, Sub programs, Attributes, HDL modeling of Combinational, Sequential circuits. Design of Basic Digital Systems using VHDL/Verilog

Case Studies: Design of Traffic Light Controller

Reference Books: Charles H. Roth Jr., "Fundamentals of Logic Design," Cengage Learning.

***Mapping of Course Outcomes for Unit IV:** CO4

Unit V - Applications of Digital Logic (05 Hours)

Design Principles and Best Practices. FPGA and CPLD, Digital Systems in Communication, Computer Architecture, and Embedded Systems. Digital Signal Processing Fundamentals. Introduction to Microcontrollers and their Digital Logic. Case Studies in Modern Applications (Robotics, IoT)

Reference Books: Charles H. Roth Jr., "Fundamentals of Logic Design," Cengage Learning.

***Mapping of Course Outcomes for Unit V:** CO5

Learning Resources

Text Books:

1. R.P. Jain, “Modern digital electronics”, 3rd edition, 12th reprint TMH Publication, 2007.
2. Stephen Brown, “Fundamentals of digital logic design with VHDL” 1st edition, TMH Publication 2002.

Reference Books:

1. M. Morris Mano, "Digital Design," Pearson.
2. John F. Wakerly, "Digital Design: Principles and Practices," Pearson.
3. Mark Bach, “Complete Digital Design”, Tata MCGraw Hill, 2005.
4. Charles H. Roth Jr., "Fundamentals of Logic Design," Cengage Learning.
5. Douglas Perry, “VHDL programming by examples”, TMH

6. J Bhaskar, “A VHDL primer”, Pearson

7. Hamacher, Zaky, “Computer Organisation”, McGraw Hill, 5th edition

e-Books:

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

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

MOOC / NPTEL/YouTube Links: -

1. Digital Circuits by Prof.Santanu Chattopadhyay
   https://swayam.gov.in/nd1_noc19_ee51/ preview

2. Digital Circuits and Systems by Prof.S.Srinivasan
   https://nptel.ac.in/courses/117/106/ 117106086/

3. NPTEL Course on :VLSI Technology”,by Dr.Nandita Dasgupta,IIT Madras
   https: //nptel.ac.in/courses/117106093

4. NPTELCourse on VLSI Circuits:,by Prof.S.Srinivasan,IIT Madras
   https://nptel.ac.in/ courses/11706092

Savitribai Phule Pune University Second Year of Computer Science (2024 Course)		
EEM-231-CSC: Entrepreneurship Development		
Teaching Scheme	**Credits**	**Examination Scheme**
Tutorial : 01 Hours/Week **Practical** : 02 Hours/Week	**Tutorial :** 01 **Practical** : 01	**Term Work** : 25 Marks

Course Objectives: The course aims to:

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

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

- CO1: **Describe** the role of entrepreneurship in economic growth and the startup ecosystem.
- CO2: **Apply** creative techniques to viable business ideas based on customer needs.
- CO3: **Develop** a basic business model using tools like the Business Model Canvas through market research.
- CO4: **Implement** basic marketing strategies for startups.
- CO5: **Deliver** a concise business pitch using storytelling and effective communication techniques.

Course Contents

Unit I - Introduction to Entrepreneurship (03 Hours)

Entrepreneurship: Definition and evolution, Role of entrepreneurship in economic development Role 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 Studies:
1. Ritesh Agarwal– Founder of OYO Rooms (India)
2. Falguni Nayar– Founder of Nykaa (India)
3. Nandan Nilekani– Co-founder of Infosys & Architect of Aadhaar (India) etc.

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

Creativity Techniques for Idea Generation: Definition and importance of creativity in entrepreneur ship. 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 Studies: Analyzing how "Dunzo" or "BigBasket" identified urban pain points and How "Zerodha" scaled in India with a digital-first approach

Unit III- Business Model Development (03 Hours)

Introduction to Business Model Canvas: Definition and purpose of a business model, Overview of the Business Model Canvas by Osterwalder, Benefits of using BMC for startups. Key Components of BMC: Value Proposition: Defining what unique value the product/service of fers. 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 Studies: Map the BMC for a well-known startup (e.g., Uber or Zomato).

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

Basics of Branding and Positioning: Introduction to Brand– Elements of brand identity: name, logo, voice, tone, and values. Positioning– How to create a unique space in the customer's mind. Positioning maps, Value-based positioning vs. competitor-based positioning Startup Branding Challenges Limited budget, building trust, clarity in messaging. Costing & Pricing Strategies– Fixed vs. variable costs, break-even analysis. Introduction to Digital Marketing: Distribution Channels: Traditional vs. digital distribution. Social Media Marketing: Platforms overview (Instagram, LinkedIn, Facebook, X/Twitter) Creating a content strategy and calendar Organic vs. paid reach Search Engine Optimization (SEO): Basics of how search engines work, Keyword research and content optimization, On-page vs. off-page SEO Importance of Digital Presence– Website essentials, blogs, and analytics tools. Customer Acquisition Strategies: Understanding the Customer Journey– Awareness, interest, decision, action. Early-Stage Customer Acquisition Tactics: Word-of-mouth & referrals, Influencer marketing (micro-influencers), Email marketing basics, building a landing page and collecting leads Retention vs. Acquisition– Importance of building long-term customer relationships.

Case Studies:

1. Zomato– Branding & Positioning in a Competitive Market
2. Mamaearth– Digital-First Customer Acquisition
3. Nykaa– Customer Segmentation and Channel Strategy

Unit V- Pitching & Business Communication (03 Hours)

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

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

Overview of Funding Sources: Public & private capital sources, venture capital, debt financing.

Bootstrapping: Meaning, benefits, and risks, Angel investors: Role, expectations, approach, Brief on incubators, government schemes, crowdfunding.

Case Studies:

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

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/SWAYAM Course 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

Sr.	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** (500–600words) 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: 1. 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: (a) Customer Segments (b) Value Propositions (c) Channels (d) Customer Relationships (e) Revenue Streams (f) Key Resources (g) Key Activities (h) Key Partnerships (i) 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: (a) Their pain points (b) Their reaction to your proposed solution (c) Willingness to pay or use your product/service 3. Summarize findings in a 1–1.5 page report that includes: (a) Key customer quotes or paraphrased insights (b) A revised Value Proposition or Customer Segment block (if needed) (c) A short reflection: key learning 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: • The Problem – Problem Identification • The Solution – Description of your product/service. • Value Proposition – The unique value proposition. • Target Audience – Audience for your idea. • Call to Action – E.g. request for support, funding, feedback, etc. **Deliver Your Pitch:** • Record a video and submit it with written version of your pitch. • Ensure clear speech, confident body language (for video), and persuasive tone. **Reflection (Short Write-up):** • Share what you learned about communicating your idea • Describe challenges or rewards you experienced in the process

Savitribai Phule Pune University Second Year of Computer Science (2024 Course)		
VEC-232-CSC: Universal Human Values and Professional Ethics (UHVPE)		
Teaching scheme	**Credits**	**Examination Scheme**
Theory : 02Hours/Week	02	**CCE :** 15 Marks **End-Semester:** 35 Marks

Prerequisite Courses, if any :

1. Student Induction Program (SIP)

Course Objectives: The course aims to:

1. To help the students develop a holistic, humane world-vision, and appreciate the essential complementarity between values and skills to ensure mutual happiness and prosperity
2. To elaborate on 'Self-exploration' as the process for Value Education
3. To facilitate the understanding of harmony at various levels starting from self and going towards family and society.
4. To elaborate on the salient aspects of harmony in nature and the entire existence
5. To explain how the Right understanding forms the basis of Universal human values and definitiveness of Ethical human conduct.
6. To provide the vision for a holistic way of living and facilitate transition from chaotic life to an orderly life.

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

1. **Recognize** the concept of self-exploration as the process of value education and see they have the potential to explore on their own right.
2. **Explore** the human being as the coexistence of self and body to see their real needs / basic aspirations clearly.
3. **Explain** relationship between one self and the other self as the essential part of relationship and harmony in the family.
4. **Interpret** the interconnectedness, harmony and mutual fulfilment inherent in the nature and the entire existence.
5. **Draw** ethical conclusions in the light of Right understanding facilitating the development of holistic technologies production systems and management models.

Course Contents

Unit I - Introduction to Value Education (07 Hours)

(i) Understanding Value Education
(ii) Self-exploration as the Process for Value Education
(iii) Continuous Happiness and Prosperity - the Basic Human Aspirations and their Fulfilment
(iv) Right Understanding, Relationship and Physical Facility
(v) Happiness and Prosperity - Current Scenario
(vi) Method to Fulfil the Basic Human Aspirations

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

(i) Understanding Human being as the Co-existence of the Self and the Body
(ii) Distinguishing between the Needs of the Self and the Body
(iii) The Body as an Instrument of the Self
(iv) Understanding Harmony in the Self
(v) Harmony of the Self with the Body
(vi) Programme to Ensure self-regulation and Health

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

(i) Harmony in the Family - the Basic Unit of Human Interaction "Trust' - the Foundational Value in Relationship
(ii) 'Respect' - as the Right Evaluation
(iii) Values in Human-to-Human Relationship
(iv) Understanding Harmony in the Society
(v) Vision for the Universal Human Order

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

(i) Understanding Harmony in the Nature
(ii) Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
(iii) Realizing Existence as Co-existence at All Levels
(iv) The Holistic Perception of Harmony in Existence
(v) Professional Ethics in the light of Right Understanding
(vi) Strategies for Transition towards Value-based Life and Profession

Learning Resources

Text Books:

1. A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, GP Bagaria, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-7-3 (Printed Copy), 978-81-957703-6-6 (e-book)
2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, GP Bagaria, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-5-9 (Printed Copy), 978-81-957703-0-4 (e-Book)

Reference Books:

1. P. L. Dhar, R. R. Gaur, 1990, Science and Humanism, Commonwealth Publishers.
2. A. Nagaraj, 1999, Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak
3. B. P. Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
4. A. N. Tripathy, 2003, Human Values, New Age International Publishers.
5. E. G. Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press
6. B. L. Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
7. M. Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics and Human Values, Eastern Economy Edition, Prentice Hall of India Ltd.
8. M. K. Gandhi, "The Story of my Experiments with Truth", Discovery Publisher

MOOC / NPTEL/YouTube Links: -

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

Suggested list of Assignments

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. Part 1: https://www.youtube.com/watch?v=OVAokeqQuFM Part 2: https://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 (2024 Course)		
CEF-241-CSC: Community Engagement Project		
Teaching scheme	**Credits**	**Examination Scheme**
Practical : 04 Hours/Week	02	**Term Work :** 25 Marks **Oral :** 25 Marks

Prerequisites Courses:

1. Basic understanding of social and ethical responsibilities
2. Teamwork and communication skills acquired in prior coursework or group activities
3. Familiarity with problem-solving methodologies and project planning
4. Conversation in local language

Companion Course :

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:

- CO1 - **Identify** and **Analyze** local community needs and challenges by engaging with stakeholders and evaluating real-world problems.
- CO2- **Design** and **Implement** practical, creative, and context-specific solutions using engineering principles to address community issues.
- CO3 - **Reflect** and **Evaluate** the effectiveness of their interventions and articulate lessons learned through reports and presentations.

Implementation

- A group of 3 to 4 students could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay/college premise.
- Each group /practical batch is allotted to a faculty member of the department as a mentor.
- A division of 60 students can have 3 batches of minimum 20 students. Practical load of 4 hours to be allocated to each batch.
- The group of students will be associated with a government official / village authorities /NGOs etc. concerned, allotted by the district administration, during the duration of the project.
- The Community Engagement Project should be different from the regular programmes of NSS/NCC/Gr 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, ewaste management or any other activity in an area of their studies and as per his/her aptitude.
- Oral Examination shall consist of presentation and demonstration of the project work carried out by the project groups.

Suggestive list of topics under Community Engagement Project

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

- Use/ 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

2024 Pattern

Semester IV

With effect from Academic Year 2025-26

Savitribai Phule Pune University Second Year of Computer Science (2024 Course)		
PCC-251-CSC: Database Management Systems		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03Hours/Week	03	**CCE** : 30 Marks **End-Semester:** 70 Marks

Prerequisite Courses :

1. Data Structures and Algorithms
2. Discrete Mathematics

Companion Course: Database Management Systems Laboratory (PCC-254-CSC)
Course Objectives: The course aims:

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

1. CO1: **Explain** the fundamentals of database management systems, including data models, ER modeling, and database design.
2. CO2: **Develop** and **execute** SQL and PL/SQL programs to manage and manipulate relational data.
3. CO3: **Apply** normalization techniques to improve database design and ensure data integrity.
4. CO4: **Analyze** transaction management concepts and concurrency control techniques for reliable database systems
5. 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 Studies: Study of Architecture of any DBMS like Oracle or MySQL. Design a database schema for any problem given in previous Question Papers.

***Mapping of Course Outcomes for Unit I:** CO1

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 Studies: 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.

***Mapping of Course Outcomes for Unit II:** CO2

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

***Mapping of Course Outcomes for Unit III:** CO3

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 Studies: 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.

***Mapping of Course Outcomes for Unit IV:** CO4

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 Studies: Study NoSQL Database Selection for a Social Media Platform.

***Mapping of Course Outcomes for Unit V:** CO5

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 (2024 Course)		
PCC-252-CSC: Advanced Data Structures		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03Hours/Week	03	**CCE** : 30 Marks **End-Semester:** 70 Marks

Prerequisite Courses :

1. Data Structure (PCC-201- CSC)

Companion Course: Advanced Data Structures Laboratory (PCC-255-CSC)

Course Objectives:

1. To understand advanced data structures for solving complex problems in various domains.
2. To suggest appropriate data structure and algorithm for graphical solutions of the problems.
3. To build the logic for using appropriate data structure in logical and computational solutions.
4. To choose the appropriate data structure and algorithm design method for a specified application.
5. To understand various algorithmic strategies to approach the problem solution.

Course Outcomes:

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

- CO1: **Apply** nonlinear data structure like trees for solving problems of various domains.
- CO2: **Design** and **apply** graphs as data structures in the application development.
- CO3: **Understand** and **apply** efficient Hashing methods to store and retrieve the data.
- CO4: **Design** and **apply** Search tree structures in the application development.
- CO5: **Use** appropriate modern tools to understand and **analyze** the functionalities confined to the m- way Search Trees & Heap

Course Contents

Unit I - Trees (09 Hours)

Tree- Basic terminology, Representation using sequential and linked organization, Binary tree - properties, Converting tree to binary tree, Binary tree traversals and Tree Iterators - Inorder, Preorder, Postorder, Depth First and Breadth First. Binary Search Tree (BST), BST operations, Threaded binary search tree- concepts, threads, insertion and deletion of nodes in Inorder threaded binary search tree, in order traversal of in-order threaded binary search tree.

Case Studies: Use of Binary tree in expression tree evaluation.

Reference Books: T1, T2, R1, R2

***Mapping of Course Outcomes for Unit I:** CO1

Unit II - Graph (09 Hours)

Graph: Basic Concepts, Storage representation, Adjacency matrix, adjacency list, adjacency multi list, inverse adjacency list, Dynamic graphs vs. static graphs. Traversals-Depth First Search and Breadth First Search, Minimum Spanning Tree, Greedy algorithms for computing minimum spanning

tree- Prims and Kruskal Algorithms, Dikjtra's Single source shortest path, All pairs shortest paths- Floyd-Warshall Algorithm

Case Studies: Airlines operate flights between multiple cities. Each city is a node, and each flight is an edge with a cost (ticket price or distance).Given departure and destination cities, find the cheapest flight route.

Reference Books: T1, T2, R2, R3

***Mapping of Course Outcomes for Unit II:** CO2

Unit III - Hashing (09Hours)

Introduction to Hashing: Basic Concept, Comparison with arrays, linked lists, and trees. Hash Table & Operations: Definition, structure, insertion, deletion, searching, bucket roles, and performance metrics, Hash Functions: Properties of good hash functions; Types of Hash Functions: division, multiplication, extraction, mid-square, folding, and universal hashing. Collision and Resolution Techniques, Hash Table Overflow and Management, Applications of Hashing

Case Studies: Student Records Management with Collision Handling
Reference Books: T1, T2,R5

***Mapping of Course Outcomes for Unit III:** CO3

Unit IV - Search Trees (09 Hours)

Symbol Table-Representation of Symbol Tables- Static tree table and Dynamic tree table, Weight balanced tree - Optimal Binary Search Tree (OBST), OBST as an example of Dynamic Programming, Height Balanced Tree- AVL tree. Red-Black Tree, AA tree, K-dimensional tree, Splay Tree

Case Studies: Keyword search in a document using OBST
Reference Books: T1, R1, R2, R4

***Mapping of Course Outcomes for Unit IV:** CO4

Unit V - Multi way Search Trees & Heap (09 Hours)

m- way Search Trees: Definition and properties, Searching m-way Search Trees, B Tree : Definition and properties, Insertion and Deletion in B Tree, B+ Tree : Definition and properties, Searching, Insertion and Deletion in B+ Tree.
Heap: Heap data structures basic concepts, Min and Max Heap, Realization of Heap, Heap as an ADT, Heap sort, applications of heap.

Case Studies: Inventory Management System by using Sequential File Organization and Indexed File Organization.

Reference Books: T2, R3

***Mapping of Course Outcomes for Unit V:** CO5

Learning Resources

Text Books:

Reference Books:

1. R.Gillberg, B.Forouzan—Data Structures: A Pseudocode approach with C, Cengage Learning, ISBN: 9788131503140.
2. M.Weiss—Data Structures and Algorithm Analysis in C++, 2nd edition,PearsonEducation,2002,ISBN-81- 7808-670-0.
3. Horowitz, Sahani —Fundamentals of Data Structures, GalgotiaBooksource.
4. Carrano and Henry, "Data Structures and Problem Solving with C++: Walls and Mirrors", Pearson; 6 edition, 2012

5. Data Structures and Algorithms Made Easy in C++ NarasimhaKarumanchi.

MOOC / NPTEL/YouTube Links: -

1. https://nptel.ac.in/courses/106/102/106102064/
2. https://nptel.ac.in/courses/106/105/106105085
3. https://nptel.ac.in/courses/106/106/106106127

MOOC / NPTEL/YouTube Links: -

1. https://www.ebooks.com/en-us/book/95777110/Python-data-structures-and-algorithms/benjamin-baka/
2. https://www.ebookphp.com/advanced-data-structures-epub-pdf/
3. https://www.ebookphp.com/data-structures-and-algorithms-professional-edition-beginners-guide-epub-pdf/

Savitribai Phule Pune University Second Year of Computer Science (2024 Course)		
PCC-253-CSC: Probability and Statistics		
Teaching scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week	02	**CCE** : 30 Marks **End-Semester:** 70 Marks

Prerequisite Courses : Basics of Integration and differentiation, Concepts of set theory

Course Objectives: The course aims to:

1. Learn probability distributions and their applications in data analysis
2. Learn the Central Limit Theorem and confidence interval estimation techniques for statistical inference.
3. Study sampling methods and statistical inference for data analysis.
4. Understanding hypothesis testing and statistical significance in data analysis.
5. Understand and apply correlation and regression analysis for data modeling

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

- CO1: **Apply** probability distributions, Bayes' theorem, and statistical measures for data analysis and decision-making.
- CO2: **Apply** the Central Limit Theorem and construct confidence intervals to estimate and compare population parameters.
- CO3: **Apply** statistical inference techniques to estimate population parameters from sample data.
- CO4: **Perform** hypothesis testing and statistical analysis for decision-making.
- CO5: **Apply** correlation and regression methods to interpret data trends and make predictions.

Course Contents

Unit I - Probability Basics and distributions (06 Hours)

Conditional and Total Probabilities, Bayes theorem, Random variables, Discrete Probability Distributions- Binomial, Poisson, Geometric distribution, Continuous Probability Distribution: Normal, standard normal, uniform, exponential distribution.

Case Studies: Predicting Customer Churn in Telecom Industry

Reference Books:

1. Schaum's outline of "Probability and Statistics", Fourth Edition
2. Sheldon M. Ross, "Probability and Statistics for Engineers and Scientists", Fifth Edition, ELSE-VIER Publication

***Mapping of Course Outcomes for Unit I:** CO1

Unit II - Central limit theorem (06 Hours)

Central limit theorem, Large-Sample Confidence Intervals for a Population Mean, Confidence Intervals for Proportions, Small-Sample Confidence Intervals for a Population Mean, Confidence Intervals for the Difference Between Two Means, Confidence Intervals for the Difference Between Two Proportions, Small-Sample Confidence Intervals for the Difference Between Two Means, Confidence Intervals with Paired Data.

Case Studies: Assessing Customer Satisfaction Between Two Retail Chains

Reference Books:

1. Statistics for Engineers and Scientists, Fourth Edition, William Navidi, McGraw-Hill publications
2. Rao G. S., (2018), "Probability and Statistics for Science and Engineering", 11th edition, Universities press publication – G Shankar Rao

***Mapping of Course Outcomes for Unit II:** CO2

Unit III - Sampling Theory and Statistical Estimation (06 Hours)

Population and Sample, Statistical inference, Sampling with and without replacement, Population parameters, Sample statics, Sampling distributions, Sample mean, Sampling distribution of means, Sample variances, Sampling distribution of variances, Case where population variances is unknown, Unbiased estimates and efficient estimates, point estimate and Interval Estimates

Case Studies: Estimating Average Monthly Household Expenditure in a City

Reference Books: Schaum's outline of "Probability and Statistics", Fourth Edition

***Mapping of Course Outcomes for Unit III:** CO3

Unit IV - Test of hypothesis (06 Hours)

Statistical hypothesis, Null and Alternate hypothesis, test of hypothesis and significance, Type I and Type II errors, Level of Significance, Tests involving the Normal distribution, One-Tailed and Two-Tailed tests, P value. Special tests of significance for large samples and small samples (F, chi- square, z, t- test)

Case Studies: Effectiveness of a New Drug vs. Existing Drug

Reference Books:

1. Statistics for Engineers and Scientists, Fourth Edition, William Navidi, McGraw-Hill publications
2. Rao G. S., (2018), "Probability and Statistics for Science and Engineering", 11th edition, Universities press publication – G Shankar Rao

***Mapping of Course Outcomes for Unit IV:** CO4

Unit V - Correlation and regression (06 Hours)

Introduction of correlation, correlation analysis, coefficient of correlation, probable error, regression, regression analysis, line of regression, standard error of estimate, Rank of correlation. Single and multiple regression.

Case Studies: Impact of Advertising on Sales

Reference Books:

1. Statistics for Engineers and Scientists, Fourth Edition, William Navidi, McGraw-Hill publications
2. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, Introduction to Linear Regression Analysis, Wiley, 2012.

***Mapping of Course Outcomes for Unit V:** CO5

Learning Resources

Text Books:

1. Statistics for Engineers and Scientists, Fourth Edition, William Navidi, McGraw-Hill publications
2. Schaum's outline of "Probability and Statistics", Fourth Edition

Reference Books:

1. Sheldon M. Ross, "Probability and Statistics for Engineers and Scientists", Fifth Edition, ELSEVIER Publication
2. William Feller, An introduction to probability theory and its applications.
3. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, Wiley, Year- 2018, ISBN- 1119409535
4. Johnson Richard A., Miller I., Freund J.E., (2016), "Probability and Statistics for Engineers", 9th edition, PHI publications
5. Rao G. S., (2018), "Probability and Statistics for Science and Engineering", 11th edition, Universities press publication – G Shankar Rao
6. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, Introduction to Linear Regression Analysis, Wiley, 2012
7. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Eastern Ltd.).(ISBN 978-0-470-45836-5.)
8. All of Statistics: A Concise Course in Statistical Inference" by Larry Wasserman (Springer publication).

E-Book

1. https://egrcc.github.io/docs/math/all-of-statistics.pdf
2. https://sar.ac.id/stmik_ebook/prog_file_file/XCN2xPxjGa.pdf
3. http://ndl.ethernet.edu.et/bitstream/123456789/37620/1/William%20Navidi_2015.pdf

MOOC/NPTEL/SWAYAM Course Links:

1. https://archive.nptel.ac.in/courses/111/105/111105090/
2. https://archive.nptel.ac.in/courses/111/102/111102160/

Savitribai Phule Pune University Second Year of Computer science (2024 Course)		
PCC-254-CSC: Database Management Systems Laboratory		
Teaching scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	**Practical**: 01	**Practical :** 25 Marks

Companion Course: Database Management Systems (PCC-251-CSC)
Course Objectives:

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

- CO1: **Apply** the concepts of database design by creating E-R diagrams and converting them into relational models.
- CO2: **Develop** and **execute** SQL queries for data manipulation, transaction control, and access management using DML, DCL, and TCL commands.
- CO3: **Analyze** and **implement** SQL operations, including joins, views, subqueries, stored procedures, and triggers, to optimize data retrieval and integrity.
- CO4: **Design** and **Implement** CRUD operations in MongoDB, demonstrating an understanding of NoSQL database concepts and their practical 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.

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.

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 model.
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: (a) Front End: Java/Perl/PHP/Python/Ruby/.net/any other language (b) 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 (2024 Course)		
PCC-255-CSC: Advanced Data Structures Laboratory		
Teaching scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	**Practical**: 01	**Term Work** : 25 Marks **Oral :** 25 Marks

Prerequisites Courses: Data Structure (PCC-201- CSC)
Companion Course: Advanced Data Structures(PCC-252-CSC)
Course Objectives:

1. To understand practical implementation and usage of nonlinear data structures for solving problems of different domains.
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 tables, trees, graphs, sorting algorithms and file organization.

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

- CO1: **Apply** and analyze nonlinear data structures to solve real world complex problems.
- CO2: **Choose** most appropriate data structures and apply algorithms for graphical solutions of the problems.
- CO3: **Understand** the ADT / libraries, hash tables and dictionary to design algorithms for a specific problem.
- CO4: **Analyze** the efficiency of the most appropriate data structure for creating efficient solutions for engineering design situations.
- CO5: **Apply** and **analyze** algorithm design techniques for multi-way searching.

Course Contents

Guidelines for Instructor's Manual

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

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As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Students programs maintained on cloud or college server by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory for accreditation purpose.

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Guidelines for Laboratory Conduction

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 Python, Programming tools like Jupyter Notebook, Pycharm, Spyder, 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.

Sr	List of Laboratory Experiments/Assignments (Any 10 from the given list)
1	Develop and implement a program using Python / C / C++ that demonstrates understanding of binary tree structures by performing and displaying the results of pre-order, in-order, and post-order traversals.
2	Apply your understanding of Binary Search Tree (BST) properties and Depth-First Search (DFS) algorithms by designing and implementing a program in Python / C / C++ that initiates a DFS traversal starting from the root node of a given BST. • Traverses the tree according to BST properties (i.e., left < root < right). • Identifies and includes the target node in the output if it is encountered during traversal. • Returns the path taken during traversal, regardless of whether the target node is found.
3	Given a list of directed edges and a specified root node, construct the corresponding directed graph and then implement a program in Python / C / C++ to perform a Depth-First Search (DFS) traversal. The program should output the correct order in which the nodes are visited during the DFS, starting from the root node.

4	Write a program in Python / C / C++ to implement Depth-First Search (DFS) for the purpose of detecting cycles in a directed graph. The program should traverse the graph and identify whether any cycles exist based on the DFS traversal logic.
5	Develop a program in Python / C / C++, or Java to represent a graph using both an adjacency matrix and an adjacency list. Then, perform and display the results of Depth-First Search (DFS) and Breadth-First Search (BFS) traversals on the given graph.
6	A delivery company aims to determine the shortest and most cost-effective routes between cities to reduce travel expenses. Write a program in Python / C / C++ that, for a given set of cities and connecting roads with specified distances, accepts input for the number of cities (nodes) and roads (edges). Implement the Dijkstra's Algorithm to compute the shortest path from a specified starting city to all other cities, and Displays the shortest distances from the source city to each of the other cities
7	Given a hash table that already stores integers based on a predefined hashing function, write a program in Python / C / C++ to simulate the insertion of each integer from a given array. For each integer, determine whether it can be inserted into the existing hash table according to the hashing rules, without using open addressing. The program should check the feasibility of insertion for each integer without modifying the actual hash table.
8	Given a hash table that already contains integers based on a specific hashing function, write a program in Python / C / C++ to insert each new integer from a given array into the existing hash table. Use linear probing as the collision resolution strategy during insertion.
9	Write a program in Python / C / C++ to implement the optimal binary search tree algorithm.
10	Write a program in Python / C / C++ to implement the AVL Tree
11	Write a program in Python / C / C++ to implement a simplified Heap Sort algorithm for sorting a given list of numbers. Your implementation should include the buildHeap function to construct the heap and the heapSort function to perform the sorting based on the heap structure.
12	Given an array of integers, write a program in Python / C / C++ to find the k largest elements using the Heap Sort algorithm. The program should efficiently identify and output the top k largest values from the array.

Learning Resources

Text Books:

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

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. R.Gillberg, B.Forouzan—Data Structures: A Pseudocode approach with C, Cengage Learning, ISBN: 9788131503140.

2. M.Weiss—Data Structures and Algorithm Analysis in C++, 2nd edition, Pearson Education, 2002, ISBN-81- 7808-670-0.

3. Horowitz, Sahani —Fundamentals of Data Structures, Galgotia Book source.

4. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein

5. Data Structures and Algorithms Made Easy in C++ Narasimha Karumanchi.

E Books: -

1. https://www.ebooks.com/en-us/book/95777110/Python-data-structures-and-algorithms/benjamin-baka/
2. https://www.ebookphp.com/advanced-data-structures-epub-pdf/
3. https://www.ebookphp.com/data-structures-and-algorithms-professional-edition-beginners-guide-epub-pdf/

MOOC / NPTEL/YouTube Links: -

- https://nptel.ac.in/courses/106/102/106102064/
- https://nptel.ac.in/courses/106/105/106105085
- https://nptel.ac.in/courses/106/106/106106127

Virtual Lab Links: -

1. https://ds2-iiith.vlabs.ac.in/List%20of%20experiments.html
2. https://ds2-iiith.vlabs.ac.in/List%20of%20experiments.html

Savitribai Phule Pune University Second Year of Computer Science (2024 Course)		
MDM-271-CSC: Internet of Things		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 02Hours/Week	02	**CCE** : 30 Marks **End-Semester:** 70 Marks

Prerequisite Courses, if any :

1. Digital Electronics and Logic Design

Companion Course if any: NA

Course Objectives: The course aims to:

1. To study the fundamentals about IoT
2. To acquire knowledge of sensor, actuators
3. To understand about IoT Access technologies and understand application protocols for IoT
4. To comprehend cloud and services in the field of IoT
5. To develop various application in IoT

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

- CO1: **Understand** fundamental and ecosystem of IoT.
- CO2: **Interface** different sensors and actuators with IoT development boards.
- CO3: **Illustrate** different layers of IoT protocols.
- CO4: **Use** of cloud and its services.
- CO5:**Apply** and **develop** domain specific IoT applications.

Course Contents

Unit I - Introduction to IoT (06 Hours)

What is Internet of Things: Definition & Characteristics of IoT, Evolution of IoT, Convergence of IoT, IoT Challenges, M2M Communication, Things in IoT, IoT Protocols, Functional blocks of IoT Ecosystem, Communication Models, Communication APIs, IoT enabled Technologies: Wireless Sensor Network, Cloud Computing, Big Data Analytics, Embedded Systems, IoT enabled Applications.

Case Studies: Home Automation

Reference Books: T3, R1

***Mapping of Course Outcomes for Unit I:** CO1

Unit II - Introduction to Sensors, Actuator (06 Hours)

Sensors/Transducers – Definition, Principles, Classifications, Types, Characteristics and Specifications,

Actuators - Definition, Principles, Classifications, Types, Characteristics and Specifications

IoT Development Boards: Arduino IDE and Board Types, Raspberry Pi, NodeMCU, ESP 32, Beaglebone

Case Studies: Interfacing Sensors

Reference Books: R3

***Mapping of Course Outcomes for Unit II:** CO2

Unit III - Protocols for IoT (06 Hours)

IoT Access Technologies: Physical and MAC layers, IEEE 802.15.4, 802.11ah and Lora WAN,

Network Layer- IP versions 4 & 6 ,6LoWPAN,

IoT Application Layer Protocols – CoAP and MQTT,

Transport Protocols - Zigbee, Bluetooth, BLE, ZWave

Case Studies: MQTT

Reference Books: T1, R1

***Mapping of Course Outcomes for Unit III:** CO3

Unit IV - Cloud for IoT (06 Hours)

Fundamentals of Cloud Computing, Types of Cloud services- AWS, Azure, Adafruit, IoT with Cloud, Challenges faced in cloud services, selection of cloud for IoT applications

Case Studies: How to use Adafruit cloud

Reference Books: R1, https://io.adafruit.com/

***Mapping of Course Outcomes for Unit IV:** CO4

Unit V - IoT Applications (06 Hours)

Smart Cities – Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance

Energy – Smart Grids, Renewable Energy Systems, Prognostics

Environment – Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection

Agriculture – Smart Irrigation, GreenHouse Control

Industry – Machine Diagnostics & Prognosis, Indoor Air Quality Monitoring

Health & Lifestyle – Health & Fitness Monitoring, Wearable Electronics

Case Studies: IoT Analytics: Thingspeak

Reference Books: R4

***Mapping of Course Outcomes for Unit V:** CO5

Learning Resources

Text Books:-

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, “IoT Fundamentals – Networking Technologies, Protocols, and Use Cases for the Internet of Things”, 1st Edition, Published by Pearson Education, Inc, publishing as Cisco Press, 2017.
2. Hakima Chaouchi, “The Internet of Things - Connecting Objects to the Web”, 1st Edition, Wiley, 2010.
3. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – Hands-On Approach”, 2nd Edition, Universities Press, 2016.
4. Perry Lea, “Internet of things For Architects”, 1st Edition, Packt Publication, 2018
5. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri, “Internet of Things:Architectures, Protocols and Standards”, Wiley

Reference Books:-

1. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill Education, 1st Edition, 2017
2. Adrian McEwen & Hakim Cassimally, “Designing the Internet of Things”, 1st Edition, Wiley, 2014.
3. David Hanes, Gonzalo Salgueiro, IoT Fundamentals Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 1st Edition, 2017.
4. Donald Norris, “Raspberry Pi – Projects for the Evil Genius”, 2nd Edition, McGraw Hill, 2014.

MOOC / NPTEL/YouTube Links: -

1. https://onlinecourses.nptel.ac.in/noc22_cs53/preview
2. https://www.youtube.com/watch?v=WUYAjxnwjU4&list=PLaxu2gn-9WXMf_ln5pMvxjf043jzof4-i
3. https://www.youtube.com/watch?v=BXDxYh1EV2w&list=PLaxu2gn-9WXMf_ln5pMvxjf043jzof4-i&index=2

E Books: -

1. https://pg.its.edu.in/sites/default/files/KCA043%20Internet%20of%20things%20IoT%20by%20Raj%20Kamal%20Text%20Book.pdf
2. https://aitskadapa.ac.in/e-books/CSE/IOT/Internet%20of%20Things_%20Architectures,%20Protocols%20and%20Standards%20(%20PDFDrive%20).pdf
3. https://jcer.in/jcer-docs/E-Learning/Digital%20Library%20/E-Books/Internet-of-things-a-hands-on-approach-%20Arshadeep.pdf

Savitribai Phule Pune University Second Year of Computer Science (2024 Course)		
VSE-281-CSC: Object Oriented Programming in Java		
Teaching scheme	**Credits**	**Examination Scheme**
Practical : 04 Hours/Week	**Practical** : 02	**Term Work** : 25 Marks **Practical** : 25 Marks

Prerequisite Courses : Fundamentals of JAVA

Companion Course : NA

Course Objectives: The course aims to:

1. To understand the basic concepts of Java Programming.

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

- CO1: **Develop** Object-Oriented Programs.
- CO2: **Understand** Java Fundamentals.
- CO3: **Develop** Problem-Solving Skills.
- CO4: A**cquire** practical knowledge of using common Java Standard Library and important packages.
- CO5: **Learn** to handle runtime errors effectively using exception handling mechanisms in Java.

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: - Java.

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 (All are Compulsory)
1	Write a java program to perform the following operations: 1. To check even or odd numbers. 2. To display the Fibonacci series. 3. To calculate Simple Interest. 4. Find a maximum of three numbers.
2	Define a class to represent a bank account. Include the following members: Data members: - Name of depositor, Account number, Type of account, Balance amount in the account Member functions: - To assign initial values, to deposit an amount, to withdraw an amount after checking the balance, to display name & balance. Write a java program by using class and object.
3	Develop a java program that defines an abstract class called Shape, which includes two integer variables and an empty method named printArea(). Create three subclasses: Rectangle, Triangle, and Circle, each extending the Shape class. In each subclass, implement the printArea() method to calculate and display the area of the respective shape.
4	Create a Stud class to display student information by using a constructor and destructor. (Implement a default constructor, multiple constructors, a copy constructor, and an overloaded constructor).
	Group B (Any Four)

5	Write Programs in Java to sort i) an array in ascending order: ii) to convert char Array to String.
6	Develop a Java program that declares an integer called day, where its value signifies a day of the week (ranging from 1 to 7). The program should then output the corresponding name of the day according to the value of day, using switch case statements.
7	Create a Java program that imports a user-defined package and utilizes the members of the classes contained in the package. Use Employee data.
8	Create a Java program that generates threads by extending the Thread class to print consecutive data.
9	Write a Java program to implement types of inheritance. Use library data.
10	Write a Java program to perform arithmetic operations of two complex numbers using class.
	Group C (Any Three)
11	Write a JAVA program to demonstrate exception handling mechanisms.
12	Write a Java program to read and display content of a file preceding line number.
13	Write a Java program to sort the given inputs by using function templates.
14	Write a Java program to store marks scored in subject "Object Oriented Programming" by N students in the class for the following operations: a) The average score of class b) Highest score and lowest score of class c) Count of students who were absent for the test d) Display mark with highest frequency
	Group D (Any One)
15	Design a mini project using Java which will use the different data structure with or without Java collection library and show the use of specific data structure on the efficiency (performance) of the code.
16	Design a mini project to implement a Smart text editor.

Learning Resources

Text Books

1. E Balagurusamy, "Programming with JAVA", Tata McGraw Hill, 7th Edition.
2. Herbert Schildt, "Java: The complete reference", Tata McGraw Hill, 7th Edition.

Reference Books

1. Cay Horstmann , "Core Java Volume 1", Kindle, 11th Edition.
2. T. Budd, "Understanding OOP with Java", Pearson Education, 2nd Updated Edition.

E-Books:

1. "Introduction to Programming Using Java", David J. Eck, Version 5.0, December 2006

MOOC/NPTEL/SWAYAM Course Links:

1. https://java-programming.mooc.fi/

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

Course Objectives: The course aims to:

अभ्यासक्रमाची उद्दिष्टे :

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

Course Contents

Unit I & II (07 Hours & 08 Hours)

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

Unit III & IV (07 Hours & 08 Hours)

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

Learning Resources

Text Books:

संदर्भ ग्रंथ :

१ सायबर संस्कृती, डॉ. रमेश वरखेडे
२ उपयोजित मराठी, संपादक डॉ. केतकी मोडक, संतोष शेणई, सुजाता शेणई
३ ओळख माहिती तंत्रज्ञानाची, टिमोथी जे. ओ लिअरी
४ संगणक, अच्युत गोडबोले, मौज प्रकाशन, मुंबई.
५ इंटरनेट, डॉ. प्रबोध चोबे, मनोरमा प्रकाशन, मुंबई.
६ व्यावहारिक मराठी, डॉ. ल. रा. नसिराबादकर, फडके प्रकाशन, कोल्हापूर.
७ आधुनिक माहिती तंत्रज्ञानाच्या विश्वात, शिक्रापूरकर दीपक, मराठे उज्ज्वल, उत्कर्ष प्रकाशन, पुणे.

Guidelines Term Work conduction and Evaluation:

Implementation Guidelines:

1. Subject teacher should frame minimum 08 assignments-based covering on all four units.
2. **Scaffolding**: Start with simpler tasks and gradually increase complexity. Provide necessary vocabulary and grammatical structures beforehand.
3. **Differentiation**: Offer varied levels of support for students with different 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 (2024 Course)		
EEM-283-CSC: Intellectual Property Rights		
Teaching scheme	**Credits**	**Examination Scheme**
Tutorial : 01 Hours/Week **Practical** : 02 Hours/Week	**Tutorial :** 01 **Practical** : 01	**Term Work** : 25 Marks

Prerequisite Courses : NA

Companion Course : NA

Course Objectives: The course aims to:

1. To Understand the Basics of Intellectual Property Rights
2. To Study types of Intellectual Property Rights (IPR)
3. To be able to describe processes, frameworks for patent protection.
4. To be able to Compare IPR protection and enforcement across major countries

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

- CO1: **Describe** Intellectual Property, its types, and related laws in India and globally.
- CO2: **Compare** different types of IPR
- CO3: **Analyze** prior art, the patent grant process, and patent enforcement strategies.
- CO4: **Evaluate** the role of HEIs, challenges, and government initiatives in strengthening IPR.
- CO5: **Analyze** global and Indian IPR laws and technological challenges.

Course Contents

Unit I - Introduction to Intellectual Property Rights

Concept of property, Intellectual Property (IP) and Intellectual Property Rights (IPR), Importance of IP, Geographical indications, IP Acts in India, Advantages of IP protection Evolution of IP system Historical view of IP system in India, WTO (world trade organization TRIPS (Trade-Related Aspects of Intellectual Property Rights) agreement, Role of WIPO (The World Intellectual Property Organization).

Case Studies: The Case of the "Bicycle Pedal" (Bajaj Auto Ltd.)

Reference Books:

1. B. L. Wadhera on patent, Trademarks, and copyright law.
2. P. Narayan on intellectual property law.
3. G.B. Reddy, Intellectual Property Law.
4. Meenu Paul, Intellectual Property Law.
5. S.R. Myneni, Intellectual Property Law

***Mapping of Course Outcomes for Unit I:** CO1

Unit II - Types of IPR

Introduction to Types of IPR: Definition and importance of different IPRs, Types of Intellectual Property Rights: CopyRight, Patent, Trade Mark, Trade Secret and trade dress, Comparison between different types of IPR. Design, Layout Design, Geographical Indication. Application of different types of IPR

Case Studies: Case Study on the Intellectual Property in Mobile Applications (https://www.wipo.int/export/in-mobile-applications.pdf

Reference Books: Intellectual Property Rights" – Neeraj Pandey & Khushdeep Dharni

***Mapping of Course Outcomes for Unit II:** CO2

Unit III - Patent System and Procedures

Patentability Requirements and Prior Art Search- Patentability Criteria: Novelty, Non-Obviousness Inventive Step, Prior Art and Its Role in Patent Granting,

Patent Filing Process and Documentation- Patent Filing Steps: Provisional vs. Non-Provisional Applications, Drafting a Patent Application, National vs. International Patent Filing, Patent Examination and Grant

Process- Patent Examination Stages: Formality Check, Substantive Examination, Office Actions and Responses, Patent Opposition and Appeals, Patent Grant and Publication.

Patent Enforcement, Licensing, and Commercialization- Patent Infringement and Legal Remedies, Patent Litigation and Dispute Resolution, Patent Licensing and Technology Transfer.

Case Studies: Case Studies on Patent Disputes and Enforcement

Reference Books:

Block-2: Patent Filing and Commercialization

Publisher: IGNOU (eGyanKosh)

Fundamentals of Patenting and Licensing for Scientists and Engineers Matthew Y. Ma

***Mapping of Course Outcomes for Unit III:** CO3

Unit IV - IPR Protection and Enforcement

Introduction to IPR Protection and Enforcement in Major Countries- India, United States (USA), European Union (EU), China and Japan, Comparison of IPR Protection and Enforcement in Major Countries, Enforcement of IPR Under NEP 2020- Strengthening Legal and Administrative Framework, Role of Higher Education Institutions (HEIs) in IPR Protection, Challenges in IPR Protection & Enforcement in India. Recent Developments & Government Initiatives.

Case Studies:

1. India: Bajaj Auto vs. TVS Motors (Patent Infringement, 2007-2009)
2. Disney Enterprises vs. Santosh Kumar (Copyright Piracy, 2018)
3. Amazon Seller Services Pvt. Ltd. v. Lifestyle Equities C.V. & Anr.(2025) etc

Reference Books:

1. Intellectual Property Law by P. Narayanan, 3rd Edition, Published by Eastern Law House
2. Law Relation to Intellectual Property by Dr. B L Wadehra, 5th Edition, Published by Universal LexisNexis

***Mapping of Course Outcomes for Unit IV:** CO4

Unit V - IPR in the Digital Age: Emerging Trends

[A] Introduction to IPR in the Digital Age: Brief introduction to IPR in the Digital Age, Concept of IPR in digital environments, Importance of IPR in protecting digital assets, Copyright challenges in the digital era, Patents and software innovations, Open-source licensing and Creative Commons, Role of blockchain in IPR protection, Artificial Intelligence (AI) and patenting issues, Role of cyber security in IPR enforcement, Software piracy and protection mechanisms.
[B] Technology & IPR: Global IPR laws (WIPO, TRIPS Agreement, etc.), IPR in India: Copyright Act, IT Act, and Patent Laws, Case studies on landmark IPR violations and resolutions

Case Studies:

1. Google v. Oracle (API Copyright Dispute)
2. YouTube Content ID System for copyright enforcement

Reference Books:

1. " Digital Copyright: Law and Practice – Simon Stokes
2. Intellectual Property Rights: Unleashing the Knowledge Economy – Prabuddha Ganguli

***Mapping of Course Outcomes for Unit V:** CO5

Term Work Assessment Guidelines:

Students must submit the report of all conducted activities of at least 08 activities out of 10 from a group of 02-03 students.
The brief guidelines for report preparations are as follows:

1. One activity report must be of maximum 3 pages.
2. Follow Structured Formatting
    - Each assignment should include: Title and assignment number, Objective or purpose
    - Main content (with subheadings where applicable) Conclusion or summary
    - References (books, articles, websites)
3. Use Authentic and Verified SourcesEncourage use of course textbooks, official websites (e.g., WIPO, IPO India), and reputed legal portals.
4. Promote Individual Understanding Students must write in their own words to reflect understanding.

5. Incorporate Case Examples Wherever applicable, support answers with real-world case studies or contemporary IPR issues.Students can use Indian and international examples to enhance analysis.

Combined Report of all activities with cover pages, table of contents and certificate (signed by instructor) is to be submitted in hard copy format only.

Course Contents

Suggested List of Laboratory Experiments/Assignments

Sr.	Suggested List of Laboratory Assignments (Any 08 Assignments)
1	**Introduction to IPR** Define IP and IPR. Discuss the importance and advantages of IP protection. Include a short note on Geographical Indications in India.
2	**Evolution of IP System** Trace the historical development of the IP system in India. Explain the role of WTO, TRIPS, and WIPO..
3	**Types of IPR** Compare and contrast Patents, Trademarks, Copyrights, Trade Secrets, and Designs.Provide real-life examples for each..
4	**Copyright in the Digital Era** Discuss how digital technology affects copyright laws. Include examples of software/music piracy and protection mechanisms.
5	**Patent Filing Process** Describe the steps in the patent filing process. Highlight the difference between national and international filings.
6	**Patentability and Prior Art** Explain novelty, non-obviousness, and usefulness with examples. Conduct a simple prior art search using Google Patents.
7	**IPR Protection in Different Countries** Compare IPR protection mechanisms in India, USA, EU, China, and Japan. Analyze one case of cross-border IPR conflict.
8	**HEIs and IPR under NEP 2020** Evaluate the role of Higher Education Institutions in promoting IPR. Summarize the challenges and reforms suggested in NEP 2020.
9	**AI, Blockchain & IPR** Discuss how AI and blockchain are reshaping the IP landscape. Cite recent tech-related IPR disputes.
10	**Open Source & Creative Commons** Differentiate between proprietary and open-source licensing. Explain the types of Creative Commons licenses with examples.
	Mini-Projects (Any One Mini Project)
1	**Mini Project 1: Case Study Portfolio** Analyze 3 real-world IPR case studies (e.g., Google vs. Oracle, Bajaj vs. TVS, YouTube Content ID). Present a report and summary presentation including legal issues, verdicts, and implications.
2	**Mini Project 2: Patent Drafting and Filing Simulation** Select a fictional or real innovative idea. Draft a basic patent specification and simulate a patent filing process. Include prior art search screenshots and draft claims.

3	**Mini Project 3: Survey and Awareness Campaign on IPR** Conduct a campus or online survey on IPR awareness among students. Analyze data and prepare an awareness report with infographics. Optionally, create an awareness video or poster campaign.

Learning Resources

Text Books

1. Intellectual Property Rights: Unleashing the Knowledge Economy – Prabuddha Ganguli ISBN 978-0070077171 McGraw Hill Education

Reference Books

1. B. L. Wadhera on patent, Trademarks, and copyright law. Universal Law Publishing ISBN 978-9350350300
2. Intellectual Property Rights" – Neeraj Pandey & Khushdeep Dharni. ISBN 978-8120349896
3. Fundamentals Of Patenting And Licensing For Scientists And Engineers (2nd Edition) 978-9814452533
4. Intellectual Property Law by P. Narayanan, 3rd Edition, Published by Eastern Law House 97881717736
5. Digital Copyright: Law and Practice – Simon Stokes ISBN 978-1509917297 Hart Publishing; 5th edition

E-Books:

1. WIPO Guide on Intellectual Property Rights (www.wipo.int)
2. Digital Copyright Handbook (www.unesco.org)

MOOC/NPTEL/SWAYAM Course Links:

1. NPTEL Course on Intellectual Property Rights and Competition Law (NPTEL Website)
2. SWAYAM Course on Intellectual Property Rights (SWAYAM Portal)

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

Prerequisites Courses: NA
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 II - 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 (08 Hours)

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
3.

E-Books Links: -

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

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