Curriculum
for
Second Year of Artificial Intelligence and Data Science
(2020 Course)
(With effect from 2021-22)

http://unipune.ac.in

Faculty of Science and Technology
Savitribai Phule Pune University
Maharashtra, India

(With effect from Academic Year 2021-22)		
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Savitribai Phule Pune University **Bachelor of Computer Engineering**

Program Outcomes (POs)

Learners are expected to know and be able to–

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

Program Specific Outcomes (PSO)

A graduate of the Computer Engineering Program will demonstrate-

PSO1	**Professional Skills**-The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, networking, artificial intelligence and data science 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.

	Savitribai Phule Pune University **Second Year of Artificial Intelligence and Data Science (2020 Course)** (With effect from Academic Year 2021-22)													
	Semester-III													
Course Code	**Course Name**	**Teaching Scheme (Hours/Week)**			**Examination Scheme and Marks**						**Credit Scheme**			
		Lecture	Practical	Tutorial	Mid-Sem	End-Sem	Term work	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
210241	Discrete Mathematics	03	-	-	30	70	-	-	-	100	03	--	-	03
210242	Fundamentals of Data Structures	03	-	-	30	70	-	-	-	100	03	-	-	03
210243	Object Oriented Programming (OOP)	03	-	-	30	70	-	-	-	100	03	-	-	03
210244	Computer Graphics	03	-	-	30	70	-	-	-	100	03	-	-	03
217521	Operating Systems	03	-	-	30	70	-	-	-	100	03	-	-	03
217522	Data Structures Laboratory	-	04	-	-	-	25	50	-	75	-	02	-	02
217523	OOP and Computer Graphics Laboratory	-	04	-	-	-	25	25	-	50	-	02	-	02
217524	Operating Systems Laboratory	-	02	-	-	-	25	-	-	25	-	01	-	01
217525	Business Communication Skills	-	02	-	-	-	25	-	-	25	-	01	-	01
217526	Humanity and Social Science	-	-	01	-	-	25	-	-	25	-	-	01	01
217527	Audit Course 3	Grade												
	Total	15	12	01	150	350	125	75	-	700	-	-	-	-
	Total Credit										15	06	01	22

217526: Options for Audit Course 3	
Audit Course Code	**Audit Course Title**
217527-I	Green Construction and Design
217527-II	Social Awareness and Governance Program
217527-III	Environmental Studies
217527-IV	Smart Cities
217527-V	Foreign Language (one of Japanese/Spanish/French/German). Course contents for **Japanese(Module 1)** are provided. For other languages institute may design suitably.

<table>
<tr><td colspan="20" align="center">

Savitribai Phule Pune University

Second Year of Artificial Intelligence and Data Science (2020 Course)

(With effect from Academic Year 2021-22)

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</table>

Semester-IV

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	Mid-Sem	End-Sem	Term work	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
217528	Statistics	03	-	-	30	70	-	-	-	100	03	--	-	03
217529	Internet of Things	03	-	-	30	70	-	-	-	100	03	-	-	03
210252	Data Structures and Algorithms	03	-	-	30	70	-	-	-	100	03	-	-	03
210253	Software Engineering	03	-	-	30	70	-	-	-	100	03	-	-	03
217530	Management Information System	03	-	-	30	70	-	-	-	100	03	-	-	03
217531	Internet of Things Laboratory	-	04	-	-	-	50	25	-	75	-	02	-	02
217532	Data Structures and Algorithms Laboratory	-	04	-	-	-	25	25	-	50	-	02	-	02
217533	Project Based Learning II	-	04	-	-	-	50	-	-	50	-	02	-	02
217534	Code of Conduct	-	-	01	-	-	25	-	-	25	-	-	01	01
217535	Audit Course 4	Grade												
	Total	**15**	**12**	**01**	**150**	**350**	**150**	**50**	**-**	**700**	**-**	**-**	**-**	**-**
									Total Credit		**15**	**06**	**01**	**22**

217535: Options for Audit Course 4	
Audit Course Code	**Audit Course Title**
217535-I	Water Management
217535-II	Intellectual Property Rights and Patents
217535-III	The Science of Happiness
217535-IV	Stress Relief: Yoga and Meditation
217535-V	Foreign Language (one of Japanese/Spanish/French/German) Course contents for **Japanese(Module 2)** are provided. For other languages institute may design suitably.

General Guidelines

1. Every undergraduate program has its own objectives and educational outcomes. These objectives and outcomes are furnished by considering various aspects and impacts of the curriculum. The **Program Outcomes (POs)** are categorically mentioned at the beginning of the curriculum (ref: NBA Manual). There should always be a rationale and a goal behind the inclusion of a course in the curriculum. Course Outcomes though highly rely on the contents of the course; many-a-times are generic and bundled. The **Course Objectives**, **Course Outcomes** and **CO-PO mappings matrix** justifies the motives, accomplishment and prospect behind learning the course. The Course Objectives, and Course Outcomes are provided for reference and these are indicative only. The course instructor may modify them as per his or her perspective.

2. @:**CO and PO Mapping Matrix** (Course Outcomes and Program Outcomes)- The **expected** attainment mapping matrix at end of course contents, indicates the correlation levels of 3, 2, 1 and '-'. The notation of 3, 2 and 1 denotes substantially (high), moderately (medium) and slightly (low). The mark '-' indicates that there is no correlation between the respective CO and PO. CO-PO Mapping Matrix values are provided for reference and these are indicative only. The course instructor may modify them as per his or her perspective.

3. #:**Elaborated examples/Case Studies-** For each course, contents are divided into six units-I, II, III, IV, V and VI. Elaborated examples/Case Studies are included at the end of each unit to explore how the learned topics apply to real world situations and need to be explored so as to assist students to increase their competencies, inculcating the specific skills, building the knowledge to be applicable in any given situation along with an articulation. One or two sample exemplars or case studies are included for each unit; instructor may extend the same with more. **Exemplar/Case Studies** may be assigned as self-study by students and to be excluded from theory examinations.

4. *:For each unit contents, the desired content attainment mapping is indicated with Course Outcome(s). Instructor may revise the same as per their viewpoint.

5. For laboratory courses, set of suggested assignments is provided for reference. Laboratory Instructors may design suitable set of assignments for respective course at their level. Beyond curriculum assignments and mini-project may be included as a part of laboratory work. The Inclusion of few optional assignments that are intricate and/or beyond the scope of curriculum will surely be the value addition for the students and it will satisfy the intellectuals within the group of the learners and will add to the perspective of the learners.

6. For each laboratory assignment, it is essential for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorial may be as per guidelines of authority.

7. For each course, irrespective of the examination head, the instructor should motivate students to read and publish articles, research papers related to recent development and invention in the field.

8. For laboratory, instructions have been included about the conduction and assessment of laboratory work. These guidelines are to be strictly followed. Use of open source software is appreciated.

9. **Term Work**[1]–Term work is continuous assessment that evaluates a student's progress throughout the semester[1]. Term work assessment criteria specify the standards that must be met and the evidence that will be gathered to demonstrate the achievement of course outcomes. Categorical assessment criteria for the term work should establish unambiguous standards of achievement for each course outcome. They should describe what the learner is expected to perform in the laboratories or on the fields to show that the course outcomes have been achieved. It is recommended to conduct internal monthly practical examination as part of continuous assessment.

Students' work will be evaluated typically based on the criteria like attentiveness, proficiency in execution of the task, regularity, punctuality, use of referencing, accuracy of language, use of supporting evidence in drawing conclusions, quality of critical thinking and similar performance measuring criteria.

10. **Laboratory Journal-** Program codes with sample output of all performed assignments are to be submitted as softcopy. Use of DVD or similar media containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory. 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. Submission of journal/ term work in the form of softcopy is desirable and appreciated.

11. **Tutorial**[1] **-** Tutorials can never be an individual course but an additional aid to the learners. Tutorials help the learners to inculcate the contents of the course with focused efforts on small group of the learners. Tutorial conduction should concentrate more on simplifying the intricacies converging to clear understanding and application. **Assessment of tutorial work is to be done in a manner similar to assessment of term-work; do follow same guidelines.**

12. **Audit Course**[1] The student registered for audit course shall be awarded the grade AP/PP (Audit Course Pass) and the grade 'AP'/'PP' shall be included in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory performance and secured a passing grade in that audit course. No grade points are associated with this 'AP'/'PP'' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself.

13. **$**:For courses 217529: Business Communication Skills, 217530: Humanity and Social Science and 217534: Code of Conduct, one credit can be earned by student if student successfully completes the Swayam course as listed in curriculum of respective course in this document.

UGC has issued the UGC (Credit Framework for online learning courses through SWAYAM) Regulation 2016 advising the Universities to identify courses where credits can be transferred on to the academic record of the students for courses done on SWAYAM. AICTE has also put out gazette notification in 2016 and subsequently for adoption of these courses for credit transfer [2].

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. This is done through a platform that facilitates hosting of the courses to be accessed by anyone, anywhere at any time. Courses delivered through SWAYAM are interactive, prepared by the best teachers in the country and are available, free of cost to any learner. However, learners wanting a SWAYAM certificate should register for the final proctored exams that come at a fee and attend in-person at designated center on specified dates. Eligibility for the certificate is generally announced on the course page. Universities/colleges approving credit transfer for these courses can use the marks/certificate obtained in these courses for the same.[2]

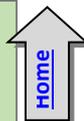**Note:** For Examination rules, pattern and assessment please refer [1]

[1]http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/Rules%20and%20Regulations%20F.E.%202019%20Patt_10.012020.pdf
[2] https://swayam.gov.in/about

Abbreviations		
TW: Term Work	**TH: Theory**	**PR: Practical**
OR: Oral	**TUT: Tutorial**	**Sem: Semester**

Semester III

Home

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) 210241: Discrete Mathematics		
Teaching Scheme	**Credit Scheme**	**Examination Scheme and Marks**
Lecture: 03 Hours/Week	**03**	**Mid_Semester(TH): 30 Marks** **End_Semester(TH): 70 Marks**

Prerequisites: Basic Mathematics

Companion Course : ---

Course Objectives:

To introduce several Discrete Mathematical Structures found to be serving as tools even today in the development of theoretical computer science.

- To introduce students to understand, explain, and apply the foundational mathematical concepts at the core of computer science.
- To understand use of set, function and relation models to understand practical examples, and interpret the associated operations and terminologies in context.
- To acquire knowledge of logic and proof techniques to expand mathematical maturity.
- To learn the fundamental counting principle, permutations, and combinations.
- To study how to model problem using graph and tree.
- To learn how abstract algebra is used in coding theory.

Course Outcomes:

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

CO1:Formulate problems precisely, solve the problems, apply formal proof techniques, and explain the reasoning clearly.

CO2:Apply appropriate mathematical concepts and skills to solve problems in both familiar and unfamiliar situations including those in real-life contexts.

CO3:Design and analyze real world engineering problems by applying set theory, propositional logic and to construct proofs using mathematical induction.

CO4:Specify, manipulate and apply equivalence relations; construct and use functions and apply these concepts to solve new problems.

CO5:Calculate numbers of possible outcomes using permutations and combinations; to model and analyze computational processes using combinatorics.

CO6:Model and solve computing problem using tree and graph and solve problems using appropriate algorithms.

CO7:Analyze the properties of binary operations, apply abstract algebra in coding theory and evaluate the algebraic structures.

Course Contents		
Unit I	**Set Theory and Logic**	**(07 Hours)**

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

#Exemplar/Case Studies	Know about the great philosophers- Georg Cantor, Richard Dedekind and Aristotle
***Mapping of Course Outcomes for Unit I**	CO1, CO2, CO3

Unit II	**Relations and Functions**	**(07 Hours)**

Relations and their Properties, n-ary relations and their applications, Representing relations, Closures of relations, Equivalence relations, Partial orderings, Partitions, Hasse diagram, Lattices, Chains and Anti-Chains, Transitive closure and Warshall's algorithm. **Functions-** Surjective, Injective and Bijective functions, Identity function, Partial function, Invertible function, Constant function, Inverse functions and Compositions of functions, The Pigeonhole Principle.

#Exemplar/Case Studies	Know about the great philosophers-Dirichlet
*Mapping of Course Outcomes for Unit II	CO2,CO4

Unit III	Counting Principles	(07 Hours)

The Basics of Counting, rule of Sum and Product, Permutations and Combinations, Binomial Coefficients and Identities, Generalized Permutations and Combinations, Algorithms for generating Permutations and Combinations.

#Exemplar/Case Studies	Study Sudoku solving algorithms and algorithm for generation of new SUDOKU. Study Hank-shake Puzzle and algorithm to solve it.
*Mapping of Course Outcomes for Unit III	CO2,CO5

Unit IV	Graph Theory	(07 Hours)

Graph Terminology and Special Types of Graphs, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, the handshaking lemma, Single source shortest path-Dijkstra's Algorithm, Planar Graphs, Graph Colouring.

#Exemplar/Case Studies	Three utility problem, Web Graph, Google map
*Mapping of Course Outcomes for Unit IV	CO1,CO2,CO6

Unit V	Trees	(07 Hours)

Introduction, properties of trees, Binary search tree, tree traversal, decision tree, prefix codes and Huffman coding, cut sets, Spanning Trees and Minimum Spanning Tree, Kruskal's and Prim's algorithms, The Max flow- Min Cut Theorem (Transport network).

#Exemplar/Case Studies	Algebraic Expression Tree, Tic-Tac-Toe Game Tree
*Mapping of Course Outcomes for Unit V	CO1,CO2,CO6

Unit VI	Algebraic Structures and Coding Theory	(07 Hours)

The structure of algebra, Algebraic Systems, Semi Groups, Monoids, Groups, Homomorphism and Normal Subgroups, and Congruence relations, Rings, Integral Domains and Fields, Coding theory, Polynomial Rings and polynomial Codes, Galois Theory –Field Theory and Group Theory.

#Exemplar/Case Studies	Cryptography used in world war II
*Mapping of Course Outcomes for Unit VI	CO1, CO2, CO7

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.
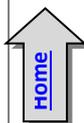
Reference Books:

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.

e-Books:

- https://www.ebookphp.com/discrete-mathematical-structures-6th-edition-epub-pdf/
- http://discrete.openmathbooks.org/pdfs/dmoi-tablet.pdf
- http://home.iitk.ac.in/~arlal/book/mth202.pdf
- https://web.stanford.edu/class/cs103x/cs103x-notes.pdf
- http://home.iitk.ac.in/~arlal/book/mth202.pdf

MOOC/ Video Lectures available at:

- https://www.nptel.ac.in/courses/106/106/106106094/
- https://nptel.ac.in/courses/106/106/106106183/
- https://nptel.ac.in/courses/106/103/106103205/
- https://nptel.ac.in/courses/106/105/106105192/
- https://nptel.ac.in/courses/111/106/111106050/
- https://nptel.ac.in/courses/111/106/111106102/

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	1	-	-	-	-	-	-	-	-
CO2	1	2	-	2	-	-	-	-	-	-	-	-
CO3	2	1	2	1	-	-	-	-	-	-	-	-
CO4	1	2	-	2	-	-	-	-	-	-	-	-
CO5	-	-	2	-	-	-	-	-	-	-	-	-
CO6	-	2	1	2	-	-	-	-	-	-	-	-
CO7	1	2	2	-	-	-	-	-	-	-	-	-

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) 210242: Fundamentals of Data Structures		
Teaching Scheme	**Credit Scheme**	**Examination Scheme and Marks**
Lecture: 03 Hours/Week	**03**	**Mid_Semester(TH): 30 Marks** **End_Semester(TH): 70 Marks**

Prerequisite Courses: 110005: Programming and Problem Solving

Companion Course: 217526: Data Structures Laboratory

Course Objectives:

The course is intended to provide the foundations of the practical implementation and usage of Data Structures and Algorithms to ensure that the learner evolves into a competent programmer capable of designing and analyzing implementations of data structures and algorithms for different kinds of problems.

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

Course Outcomes:

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

CO1:Design the algorithms to solve the programming problems, **identify** appropriate algorithmic strategy for specific application, and **analyze** the time and space complexity.

CO2:Discriminate the usage of various structures, **Design/Program/Implement** the appropriate data structures; use them in implementations of abstract data types and Identity the appropriate data structure in approaching the problem solution.

CO3:Demonstrate use of sequential data structures- Array and Linked lists to store and process data.

CO4:Understand the computational efficiency of the principal algorithms for searching and sorting and choose the most efficient one for the application.

CO5:Compare and **contrast** different implementations of data structures (dynamic and static).

CO6:Understand, Implement and apply principles of data structures-stack and queue to solve computational problems.

Course Contents

Unit I	Introduction to Algorithm and Data Structures	(07 Hours)

Introduction: From Problem to Program (Problem, Solution, Algorithm, Data Structure and Program). Data Structures: Data, Information, Knowledge, and Data structure, Abstract Data Types (ADT), Data Structure Classification (Linear and Non-linear, Static and Dynamic, Persistent and Ephemeral data structures).

Algorithms: Problem Solving, Introduction to algorithm, Characteristics of algorithm, Algorithm design tools: Pseudo-code and flowchart. **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. **Algorithmic Strategies:** Introduction to algorithm design strategies- Divide and Conquer, and Greedy strategy.

#Exemplar/Case Studies	Multiplication technique by the mathematician Carl Friedrich Gauss and Karatsuba algorithm for fast multiplication.
***Mapping of Course Outcomes for Unit I**	CO1, CO2
Unit II	**Linear Data Structure Using Sequential Organization**	**(07 Hours)**

Concept of Sequential Organization, Overview of Array, Array as an Abstract Data Type, Operations on Array, Merging of two arrays, Storage Representation and their Address Calculation: Row major and Column Major, Multidimensional Arrays: Two-dimensional arrays, n-dimensional arrays. Concept of Ordered List, **Single Variable Polynomial**: Representation using arrays, Polynomial as array of structure, Polynomial addition, Polynomial multiplication. **Sparse Matrix:** Sparse matrix representation using array, Sparse matrix addition, Transpose of sparse matrix- Simple and Fast Transpose, Time and Space tradeoff.	
#Exemplar/Case Studies	Study use of sparse matrix in Social Networks and Maps. Study how Economists use polynomials to model economic growth patterns, how medical researchers use them to describe the behaviour of Covid-19 virus.
*Mapping of Course Outcomes for Unit II	CO1, CO2, CO3

Unit III	Searching and Sorting	(07 Hours)

Searching: Search Techniques-Sequential Search/Linear Search, Variant of Sequential Search-Sentinel Search, Binary Search, Fibonacci Search, and Indexed Sequential Search. **Sorting:** Types of Sorting-Internal and External Sorting, General Sort Concepts-Sort Order, Stability, Efficiency, and Number of Passes, Comparison Based Sorting Methods-Bubble Sort, Insertion Sort, Selection Sort, Quick Sort, Shell Sort, Non-comparison Based Sorting Methods-Radix Sort, Counting Sort, and Bucket Sort, Comparison of All Sorting Methods and their complexities	
#Exemplar/Case Studies	Use of Fibonacci search in non-uniform access memory storage and in Optimization of Unimodal Functions. Timsort as a hybrid stable sorting algorithm
*Mapping of Course Outcomes for Unit III	CO1, CO2, CO4

Unit IV	Linked List	(07 Hours)

Introduction to Static and Dynamic Memory Allocation, **Linked List:** Introduction, of Linked Lists, Realization of linked list using dynamic memory management,operations, Linked List as ADT, **Types of Linked List:** singly linked, linear and Circular Linked Lists, Doubly Linked List, Doubly Circular Linked List, Primitive Operations on Linked List-Create, Traverse, Search, Insert, Delete, Sort, Concatenate. Polynomial Manipulations-Polynomial addition. Generalized Linked List (GLL) concept, Representation of Polynomial using GLL.	
#Exemplar/Case Studies	Garbage Collection
*Mapping of Course Outcomes for Unit IV	CO1, CO2, CO3, CO5

Unit V	Stack	(07 Hours)

Basic concept, stack Abstract Data Type, Representation of Stacks Using Sequential Organization, stack operations, Multiple Stacks, Applications of Stack- Expression Evaluation and Conversion, Polish notation and expression conversion, Need for prefix and postfix expressions, Postfix expression evaluation, Linked Stack and Operations. **Recursion-** concept, variants of recursion- direct, indirect, tail and tree, backtracking algorithmic strategy, use of stack in backtracking.	
#Exemplar/Case Studies	Android- multiple tasks/multiple activities and back-stack, Tower of Hanoi, 4 Queens problem.
*Mapping of Course Outcomes for Unit V	CO1, CO2, CO3, CO5, CO6

Unit VI	Queue	(07 Hours)

Basic concept, Queue as Abstract Data Type, Representation of Queue using Sequential organization,Queue Operations, Circular Queue and its advantages, Multi-queues,Linked Queue and Operations. **Deque**-Basic concept, types (Input restricted and Output restricted), Priority Queue- Basic concept, types (Ascending and Descending).

#Exemplar/Case Studies	Priority queue in bandwidth management
*Mapping of Course Outcomes for Unit VI	CO1, CO2, CO3, CO5, CO6

Learning Resources

Text Books:

1. Horowitz, Sahani, Dinesh Mehata, "Fundamentals of Data Structures in C++"‖, Galgotia Publisher, ISBN: 8175152788, 9788175152786.
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. Steven S S. Skiena, "The Algorithm Design Manual", Springer, 2nd ed. 2008 Edition, ISBN-13: 978-1849967204, ISBN-10: 1849967202.
2. Allen Downey, Jeffery Elkner, Chris Meyers, "How to think like a Computer Scientist: Learning with Python", Dreamtech Press, ISBN: 9789351198147.
3. M. Weiss, "Data Structures and Algorithm Analysis in C++", 2nd edition, Pearson Education, 2002, ISBN-81-7808-670-0.
4. Brassard and Bratley, "Fundamentals of Algorithmic", Prentice Hall India/Pearson Education, ISBN 13-9788120311312.
5. Yashwant Kanetkar & A. Kanetkar, "Let us Python", BPB Publisher, ISBN: 9789389845006

e-Books:

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

MOOC/ Video Lectures available at:

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

Other:

Know Thy Complexities! (https://www.bigocheatsheet.com/) (https://github.com/RehanSaeed/.NET-Big-O-Algorithm-Complexity-Cheat-Sheet)

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	2	-	-	-	-	-	-	-	-
CO2	1	2	2	1	-	-	-	-	-	-	-	-
CO3	1	1	1	-	-	-	-	-	-	-	-	-
CO4	1	-	1	-	-	-	-	-	-	-	-	-
CO5	1	1	-	1	-	-	-	-	-	-	-	-
CO6	1	1	1	1	1	-	-	-	-	-	-	-

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Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
210243: Object Oriented Programming(OOP)

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Lecture: 03 Hours/Week	**03**	**Mid_Semester(TH): 30 Marks** **End_Semester(TH): 70 Marks**

Prerequisite Courses : 110005: Programming and Problem Solving

Companion Course : 217523: OOP and Computer Graphics Laboratory

Course Objectives:

The course is intended to provide the foundations and in-depth understanding of a modern object-oriented language and develop skills in software development, through an algorithmic approach and the application of principles of objected oriented programming.

- To learn the object-oriented programming paradigm, focusing on the definition and use of classes along with the fundamentals of object-oriented design.
- To learn the syntax and semantics of the C++ programming language.
- To understand the concept of data abstraction and encapsulation, how to design C++ classes for code reuse, how to implement copy constructors and class member functions, to overload functions and operators in C++.
- To learn how inheritance and virtual functions implement dynamic binding with polymorphism.
- To learn how to design and implement generic classes with C++ templates and how to use exception handling in C++ programs.

Course Outcomes:

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

  CO1: Apply constructs- sequence, selection and iteration; classes and objects, inheritance, use of predefined classes from libraries while developing software.
  CO2: Design object-oriented solutions for small systems involving multiple objects.
  CO3: Use virtual and pure virtual function and complex programming situations.
  CO4: Apply object-oriented software principles in problem solving.
  CO5: Analyze the strengths of object-oriented programming.
  CO6: Develop the application using object oriented programming language(C++).

Course Contents

Unit I	Fundamentals of Object Oriented Programming	(07 Hours)

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

C++ Programming- C++ programming Basics, Data Types, Structures, Enumerations, control structures, Arrays and Strings, Class, Object, class and data abstraction, Access specifiers, separating interface from implementation. **Functions**- Function, function prototype, accessing function and utility function, Constructors and destructor, Types of constructor, Objects and Memory requirements, Static members: variable and functions, inline function, friend function.

#Exemplar/Case Studies	Story of C++ invention by Bjarne Stroustrup
*Mapping of Course Outcomes for Unit I	CO1, CO5

Unit II	Inheritance and Pointers	(07 Hours)

Inheritance- Base Class and derived Class, protected members, relationship between base Class and derived Class, Constructor and destructor in Derived Class, Overriding Member Functions, Class Hierarchies, Public and Private Inheritance, Types of Inheritance, Ambiguity in Multiple Inheritance,

Curriculum for Second Year of Artificial Intelligence and Data Science (2020 Course), Savitribai Phule Pune University

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Virtual Base Class, Abstract class, Friend Class, Nested Class.

Pointers: declaring and initializing pointers, indirection Operators, Memory Management: new and delete, Pointers to Objects, this pointer, Pointers Vs Arrays, accessing Arrays using pointers, Arrays of Pointers, Function pointers, Pointers to Pointers, Pointers to Derived classes, Passing pointers to functions, Return pointers from functions, Null pointer, void pointer.

#Exemplar/Case Studies	Know about Firefox and Thunderbird as one of the popular softwares developed using C++
*Mapping of Course Outcomes for Unit II	CO2, CO4

Unit III	Polymorphism	(07 Hours)

Polymorphism- Introduction to Polymorphism, Types of Polymorphism, Operator Overloading-concept of overloading, operator overloading, Overloading Unary Operators, Overloading Binary Operators, Data Conversion, Type casting (implicit and explicit), Pitfalls of Operator Overloading and Conversion, Keywords explicit and mutable.

Function overloading, **Run Time Polymorphism**- Pointers to Base class, virtual function and its significance in C++, pure virtual function and virtual table, virtual destructor, abstract base class.

#Exemplar/Case Studies	Study about use of C++ SDKs wrappers for Java and .Net.
*Mapping of Course Outcomes for Unit III	CO2, CO3, CO4

Unit IV	Files and Streams	(07 Hours)

Data hierarchy, Stream and files, Stream Classes, Stream Errors, Disk File I/O with Streams, File Pointers, and Error Handling in File I/O, File I/O with Member Functions, Overloading the Extraction and Insertion Operators, memory as a Stream Object, Command-Line Arguments, Printer output.

#Exemplar/Case Studies	Study features used for Microsoft Office, Internet Explorer and Visual Studio that are written in Visual C++
*Mapping of Course Outcomes for Unit IV	CO2, CO4

Unit V	Exception Handling and Templates	(07 Hours)

Exception Handling- Fundamentals, other error handling techniques, simple exception handling-Divide by Zero, Multiple catching, re-throwing an exception, exception specifications, user defined exceptions, processing unexpected exceptions, constructor, destructor and exception handling, exception and inheritance. **Templates**- The Power of Templates, Function template, overloading Function templates, and class template, class template and Nontype parameters, template and friends Generic Functions, The type name and export keywords.

#Exemplar/Case Studies	Study about use of exception handling in Symbian Operating System (discontinued mobile operating system) that was developed using C++.
*Mapping of Course Outcomes for Unit V	CO2, CO4, CO6

Unit VI	Standard Template Library (STL)	(07 Hours)

Introduction to STL, STL Components, Containers- Sequence container and associative containers, container adapters, Application of Container classes: vector, list,

Algorithms- basic searching and sorting algorithms, min-max algorithm, set operations, heap sort, **Iterators**- input, output, forward, bidirectional and random access. Object Oriented Programming – a road map to future

#Exemplar/Case Studies	Study MySQL open source C++ code available at GitHub.
*Mapping of Course Outcomes for Unit VI	CO2, CO4, CO6

Learning Resources

Text Books:

1. Deitel,"C++ How to Program", 4th Edition, Pearson Education, ISBN:81-297-0276-2
2. Robert Lafore, "Object-Oriented Programming in C++‖", fourth edition, Sams Publishing, ISBN:0672323087 (ISBN 13: 9780672323089

Reference Books:

1. Herbert Schildt, "C++-The complete reference"‖, Eighth Edition, McGraw Hill Professional, 2011, ISBN:978-00-72226805
2. Matt Weisfeld, "The Object-Oriented Thought Process", Third Edition Pearson ISBN-13:075-2063330166
3. E.Balagurusamy, "Object-Oriented Programming with C++", 7th edition, Graw-Hill Publication, ISBN 10: 9352607996 ISBN 13: 9789352607990
4. Cox Brad, Andrew J. Novobilski, "Object –Oriented Programming: An Evolutionary Approach"‖, Second Edition, Addison–Wesley, ISBN:13:978-020-1548341

e-Books:

- https://www.springer.com/gp/book/9781852334505
- https://www.ebookphp.com/object-oriented-programming-in-c-epub-pdf/
- https://www.springer.com/gp/book/9781447133780

MOOC/ Video Lectures available at:

- https://nptel.ac.in/courses/106/105/106105151/
- https://swayam.gov.in/nd1_noc20_cs07/preview
- https://www.classcentral.com/course/swayam-programming-in-c-6704

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	-	-	-	-	-	-	-	-
CO2	1	2	1	1	-	-	-	-	-	-	-	1
CO3	2	1	2	2	-	-	-	-	-	-	-	-
CO4	2	1	2	1	-	-	-	-	-	-	-	1
CO5	-	1	-	1	-	-	-	-	-	-	-	-
CO6	-	-	1	-	-	-	-	-	-	-	-	1

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) **210244: Computer Graphics**		
Teaching Scheme	**Credit Scheme**	**Examination Scheme and Marks**
Lecture: 03 Hours/Week	**03**	**Mid_Semester(TH): 30 Marks** **End_Semester(TH): 70 Marks**

Prerequisite Course:	Basic Mathematics

Companion Course: 217523: OOP and Computer Graphics Laboratory

Course Objectives:

The Computer Graphics course prepares students for activities involving the design, development, and testing of modeling, rendering, and animation solutions to a broad variety of problems found in entertainment, sciences, and engineering.

- **Remembering:** To acquaint the learner with the basic concepts of Computer Graphics.
- **Understanding:** To learn the various algorithms for generating and rendering graphical figures.
- **Applying:** To get familiar with mathematics behind the graphical transformations.
- **Understanding:** To understand and apply various methods and techniques regarding projections, animation, shading, illumination and lighting.
- **Creating:** To generate Interactive graphics using OpenGL.

Course Outcomes:

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

CO1:Identify the basic terminologies of Computer Graphics and interpret the mathematical foundation of the concepts of computer graphics.

CO2:Apply mathematics to develop Computer programs for elementary graphic operations.

CO3:Illustrate the concepts of windowing and clipping and **apply** various algorithms to fill and clip polygons.

CO4:Understand and **apply** the core concepts of computer graphics, including transformation in two and three dimensions, viewing and projection.

CO5:Understand the concepts of color models, lighting, shading models and hidden surface elimination.

CO6:Create effective programs using concepts of curves, fractals, animation and gaming.

Course Contents		
Unit I	**Graphics Primitives and Scan Conversion Algorithms**	**(07 Hours)**

Introduction, graphics primitives - pixel, resolution, aspect ratio, frame buffer. Display devices, applications of computer graphics.
Introduction to OpenGL - OpenGL architecture, primitives and attributes, simple modelling and rendering of two- and three-dimensional geometric objects, GLUT, interaction, events and call-backs picking. (**Simple Interaction with the Mouse and Keyboard)**
Scan conversion: Line drawing algorithms: Digital Differential Analyzer (DDA), Bresenham. Circle drawing algorithms: DDA, Bresenham, and Midpoint.

#Exemplar/Case Studies	Study about OpenGL Architecture Review Board (ARB)
*Mapping of Course Outcomes for Unit I	CO1, CO2

Unit II	**Polygon, Windowing and Clipping**	**(07 Hours)**

Polygons: Introduction to polygon, types: convex, concave and complex. Inside test.
Polygon Filling: flood fill, seed fill, scan line fill.
Windowing and clipping: viewing transformations, 2-D clipping: Cohen – Sutherland algorithm line Clipping algorithm, Sutherland Hodgeman Polygon clipping algorithm, Weiler Atherton Polygon Clipping algorithm.

#Exemplar/Case Studies	Study Guard-band clipping Technique and it's use in various rendering softwares, Use of 3D pipeline/ polygonal modelling and applications.
*Mapping of Course Outcomes for Unit II	CO2, CO3

Unit III	2D, 3D Transformations and Projections	(07 Hours)

2-D transformations: introduction, homogeneous coordinates, 2-D transformations - Translation, scaling, rotation and shear, rotation about an arbitrary point.
3-D transformations: introduction, 3-D transformations - Translation, scaling, rotation and shear, rotation about an arbitrary axis.
Projections : Parallel (Oblique: Cavalier, Cabinet and orthographic: isometric, diametric, trimetric) and Perspective (Vanishing Points – 1 point, 2 point and 3 point)

#Exemplar/Case Studies	Study use of transformations and projections in education and training software.
*Mapping of Course Outcomes for Unit III	CO2, CO4

Unit IV	Light, Colour, Shading and Hidden Surfaces	(07 Hours)

Colour models: Properties of Light, CIE chromaticity Diagram, RGB, HSV, CMY.
Illumination Models: Ambient Light, Diffuse reflection, Specular Reflection, and the Phong model, Combined diffuse and Specular reflections with multiple light sources, warn model,
Shading Algorithms: Halftone, Gauraud and Phong Shading.
Hidden Surfaces Introduction, Back face detection and removal, Algorithms: Depth buffer (z), Depth sorts (Painter), Area subdivision (Warnock)

#Exemplar/Case Studies	Study any popular graphics designing software
*Mapping of Course Outcomes for Unit IV	CO5

Unit V	Curves and Fractals	(07 Hours)

Curves: Introduction, Interpolation and Approximation, Blending function, B-Spline curve, Bezier curve,
Fractals: Introduction, Classification, Fractal generation: snowflake, Triadic curve, Hilbert curve, Applications.

#Exemplar/Case Studies	Case study on measuring the length of coastline using fractals
*Mapping of Course Outcomes for Unit V	CO2,CO6

Unit VI	Introduction to Animation and Gaming	(07 Hours)

Segment: Introduction, Segment table, Segment creation, closing, deleting and renaming, Visibility.
Animation: Introduction, Conventional and computer based animation, Design of animation sequences, Animation languages, Key- frame, Morphing, Motion specification.
Gaming: Introduction, Gaming platform (NVIDIA, i8060), Advances in Gaming.

#Exemplar/Case Studies	Study of any open source tools- Unity/Maya/Blender
*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

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Text Books:

1. S. Harrington, "Computer Graphics"‖, 2nd Edition, McGraw-Hill Publications, 1987, ISBN 0 07 – 100472 – 6.
2. Donald D. Hearn and Baker, "Computer Graphics with OpenGL", 4th Edition, ISBN-13: 9780136053583.
3. D. Rogers, "Procedural Elements for Computer Graphics", 2nd Edition, Tata McGraw-Hill Publication, 2001, ISBN 0 – 07 – 047371 – 4.

Reference Books:

1. J. Foley, V. Dam, S. Feiner, J. Hughes, "Computer Graphics Principles and Practice"‖, 2nd Edition, Pearson Education, 2003, ISBN 81 – 7808 – 038 – 9.
2. D. Rogers, J. Adams, "Mathematical Elements for Computer Graphics"‖, 2nd Edition, Tata McGraw Hill Publication, 2002, ISBN 0 – 07 – 048677 – 8.

e-Books:

- https://open.umn.edu/opentextbooks/textbooks/introduction-to-computer-graphics
- http://www2.cs.uidaho.edu/~jeffery/courses/324/lecture.html

MOOC/ Video Lectures available at:

- https://nptel.ac.in/courses/106/106/106106090/
- https://nptel.ac.in/courses/106/102/106102065/

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	-	-	-	-	-	-	-	-	-
CO2	3	-	1	1	-	-	-	-	-	-	-	-
CO3	1	2	-	1	-	-	-	-	-	-	-	-
CO4	2	1	1	1	-	-	-	-	-	-	-	-
CO5	1	-	1	-	-	-	-	-	-	-	-	-
CO6	-	2	2	1	-	-	-	-	-	-	-	-
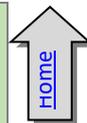
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Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) 217521: Operating Systems		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Lecture: 03 Hours/Week	**03**	**Mid_Semester(TH): 30 Marks** **End_Semester(TH): 70 Marks**

Prerequisite Courses, if any: 110005:Programming and Problem Solving

Companion Course, if any: 217524: Operating Systems Laboratory

Course Objectives:
- To understand functions of operating system
- To learn and understand process, resource and memory management.
- To learn and understand file and I/O management.

Course Outcomes:
On completion of the course, learner will be able to–
CO1: Enlist functions of OS and types of system calls
CO2: Apply process scheduling algorithms to solve a given problem
CO3: Illustrate deadlock prevention, avoidance and recovery
CO4: Explain memory management technique
CO5: Illustrate I/O and file management policies
CO6: Describe Linux process management

Course Contents

Unit I	Fundamental Concepts of Operating system	(06 Hours)

Operating system functions and characteristics, historical evolution of operating systems, issues in operating system design, User's view of the OS, Types of OS: Batch, time sharing, multiprogramming, distributed, network and real-time systems, Operating-System Services, Types of System Calls, System Programs. BASH Shell scripting: Basic shell commands, shell as a scripting language.

#Exemplar/Case Studies	Virtual Machines
Mapping of Course Outcomes for Unit I	CO1

Unit II	Process Management	(06 Hours)

Process concept, Process Control Block(PCB), Process Operations, **Process Scheduling**: Types of process schedulers, Types of scheduling: Preemptive, Non preemptive. Scheduling algorithms: FCFS, SJF, RR, Priority, Inter process Communication(IPC). **Threads**: multithreaded model, implicit threads, threading issues

#Exemplar/Case Studies	Thread programming Using Pthreads
Mapping of Course Outcomes for Unit II	CO2

Unit III	Process Coordination	(08 Hours)

Synchronization: Principles of Concurrency, Requirements for Mutual Exclusion, Mutual Exclusion: Hardware Support, Operating System Support (Semaphores and Mutex), Programming Language Support (Monitors).Classical synchronization problems:Readers/Writers Problem, Producer and Consumer problem, Inter-process communication (Pipes, shared memory: system V)
Deadlock: Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock

#Exemplar/Case Studies	Process coordination in Unix operating system
Mapping of Course Outcomes for Unit III	CO3

Unit IV	Memory Management	(06 Hours)

Memory Management: Memory Management Requirements, Memory Partitioning: Fixed Partitioning, Dynamic Partitioning, Buddy System, Relocation, Paging, Segmentation. Virtual Memory: Hardware and Control Structures, Operating System Software

#Exemplar/Case Studies	Memory Management in Unix operating system
Mapping of Course Outcomes for Unit IV	CO4

Unit V	I/O and File Management	(06 Hours)

I/O Management: I/O Devices, Organization of I/O function, I/O Buffering, Disk SchedulingDisk Scheduling policies like FIFO, LIFO, STTF, SCAN, C-SCAN.
File Management: Concept, Access methods, Directory Structure, Protection, File System implementation, Directory Implementation, Allocation methods, Free Space management.

#Exemplar/Case Studies	I/OManagement in Unix operating system
Mapping of Course Outcomes for Unit V	CO5

Unit VI	Linux	(06 Hours)

History Of Unix and Linux , Overview Of Linux - Linux Goals, Interfaces to Linux, The Shell, Linux Utility Programs, Kernel structure, Processes in Linux – Process management system calls in Linux, Implementation of process and threads in Linux, Process scheduling Linux, Booting

#Exemplar/Case Studies	Ubuntu design principles
Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:
1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, WILEY, ISBN978-1-118-06333-0, 9th Edition
2. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, ISBN-10: 0-13-380591-3, ISBN-13: 978-0-13-380591-8, 8th Edition
3. Andrew S. Tanenbaum & Herbert Bos, Modern Operating System, Pearson, ISBN-13: 9780133592221, 4th Edition

Reference Books:
1. Tom Adelstein and Bill Lubanovic, Linux System Administration, O'Reilly Media, ISBN-10: 0596009526, ISBN-13: 978-0596009526
2. Harvey M. Deitel, Operating Systems, Prentice Hall, ISBN-10: 0131828274, ISBN-13: 978-0131828278
3. Thomas W. Doeppner, Operating System in depth: Design and Programming, WILEY, ISBN: 978-0-471-68723-8
4. Mendel Cooper, Advanced Shell Scripting, Linux Documentation Project

e-Books:
https://repository.dinus.ac.id/docs/ajar/Operating_System.pdf

MOOC Courses:
1. https://nptel.ac.in/courses/106/105/106105214/
2. https://nptel.ac.in/courses/106/106/106106144/

@The CO-PO mapping table

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-		-	-	-	-	-	-	-	-	-
CO2	2	2	-	1	-	-	-	-	-	-	-	1
CO3	2	2	-	1	-	-	-	-	-	-	-	1
CO4	2	2	-	1	-	-	-	-	-	-	-	1
CO5	2	2	-	1	-	-	-	-	-	-	-	1
CO6	2	2	-	1	-	-	-	-	-	-	-	1

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217522: Data Structures Laboratory

Teaching Scheme Practical: **04 Hours/Week**	Credit Scheme **02**	Examination Scheme and Marks Term Work: **25 Marks** Practical: **50 Marks**

Companion Course: 210242: Fundamental of Data Structures

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 and C++ programming language.

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

CO1: Use algorithms on various linear data structure using sequential organization to solve real life problems.

CO2: Analyze problems to **apply** suitable searching and sorting algorithm to various applications.

CO3: Analyze problems to **use variants of** linked list and solve various real life problems.

CO4: Designing and implement data structures and algorithms for solving different kinds of problems.

Guidelines for Instructor's Manual
The instructor's manual is to be developed as a hands-on resource and reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface), curriculum of course, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and 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 **<u>handwritten write-up</u>** of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, <u>Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis.</u> **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. Use of DVD containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

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 need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute 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, instructor may assign one real life application in the form of a mini-project based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch <u>beyond the scope of syllabus.</u>

Set of suggested assignment list is provided in groups- A, B, C, D, and E. Each student must perform at least 13 assignments (at least 3 from group A, 3 from group B, 2 from group C, 2 from group D and 3 from group E.)

Group A and B assignments should be implemented in Python without using built-in methods for major functionality of assignment. Use List data structure of Python as array. Group C, D and E assignments should be implemented in C++ language.
Operating System recommended:- 64-bit Open source Linux or its derivative
Programming tools recommended: - Open Source Python, Programming tool 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.

Virtual Laboratory:

- http://cse01-iiith.vlabs.ac.in/Courses%20Aligned.html?domain=Computer%20Science

Suggested List of Laboratory Experiments/Assignments

Sr. No	Group A

1	In second year computer engineering class, group A student's play cricket, group B students play badminton and group C students play football.
	Write a Python program using functions to compute following: -
	   a) List of students who play both cricket and badminton
	   b) List of students who play either cricket or badminton but not both
	   c) Number of students who play neither cricket nor badminton
	   d) Number of students who play cricket and football but not badminton.
	(Note- While realizing the group, duplicate entries should be avoided, Do not use SET built-in functions)

2	Write a Python program to store marks scored in subject "Fundamental of Data Structure" by N students in the class. Write functions to compute following:
	   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

3	Write a **Python** program for department library which has N books, write functions for following:
	   a) Delete the duplicate entries
	   b) Display books in ascending order based on cost of books
	   c) Count number of books with cost more than 500.
	   d) Copy books in a new list which has cost less than 500.

4	Write a **Python** program that computes the net amount of a bank account based a transaction log from console input. The transaction log format is shown as following: D 100 W 200 (Withdrawal is not allowed if balance is going negative. Write functions for withdraw and deposit) D means deposit while W means withdrawal. Suppose the following input is supplied to the program: D 300, D 300 , W 200, D 100 Then, the output should be: 500

5	Write a Python program to compute following operations on String:
	   a) To display word with the longest length
	   b) To determines the frequency of occurrence of particular character in the string
	   c) To check whether given string is palindrome or not
	   d) To display index of first appearance of the substring
	   e) To count the occurrences of each word in a given string

6	It is decided that weekly greetings are to be furnished to wish the students having their birthdays in that week. The consolidated sorted list with desired categorical information is to be provided to the authority. Write a **Python** program to store students PRNs with date and month of birth. Let List_A and List_B be the two list for two SE Computer divisions. Lists are sorted on date and month. Merge these two lists into third list "List_SE_Comp_DOB" resulting in sorted information about Date of Birth of SE Computer students
7	Write a **Python** Program for magic square. A magic square is an n * n matrix of the integers 1 to n2 such that the sum of each row, column, and diagonal is the same. The figure given below is an example of magic square for case n=5. In this example, the common sum is 65.

15	8	1	24	17
16	14	7	5	23
22	20	13	6	4
3	21	19	12	10
9	2	25	18	11

8	Write a **Python** program that determines the location of a saddle point of matrix if one exists. An m x n matrix is said to have a saddle point if some entry a[i][j] is the smallest value in row i and the largest value in j.
9	Write a **Python** program to compute following computation on matrix: a) Addition of two matrices B) Subtraction of two matrices c) Multiplication of two matrices d) Transpose of a matrix
10	Write a **Python** program for sparse matrix realization and operations on it- Transpose, Fast Transpose and addition of two matrices
	Group B
11	a) Write a **Python** program to store roll numbers of student in array who attended training program in random order. Write function for searching whether particular student attended training program or not, using Linear search and Sentinel search. b) Write a **Python** program to store roll numbers of student array who attended training program in sorted order. Write function for searching whether particular student attended training program or not, using Binary search and Fibonacci search
12	a) Write a **Python** program to store names and mobile numbers of your friends in sorted order on names. Search your friend from list using binary search (recursive and non-recursive). Insert friend if not present in phonebook b) Write a **Python** program to store names and mobile numbers of your friends in sorted order on names. Search your friend from list using Fibonacci search. Insert friend if not present in phonebook.
13	Write a **Python** program to maintain club members, sort on roll numbers in ascending order. Write function "Ternary_Search" to search whether particular student is member of club or not. Ternary search is modified binary search that divides array into 3 halves instead of two.
14	Write a **Python** program to store first year percentage of students in array. Write function for sorting array of floating point numbers in ascending order using a) Selection Sort b) Bubble sort and display top five scores.
15	Write a **Python** program to store second year percentage of students in array. Write function for sorting array of floating point numbers in ascending order using a) Insertion sort b) Shell Sort and display top five scores
16	Write a **Python** program to store first year percentage of students in array. Write function for sorting array of floating point numbers in ascending order using quick sort and display top five scores.
17	Write a **Python** program to store 12th class percentage of students in array. Write function for sorting array of floating point numbers in ascending order using bucket sort and display top five scores.

18	Write **Python** program to store 10th class percentage of students in array. Write function for sorting array of floating point numbers in ascending order using radix sort and display top five scores
	Group C
19	Department of Computer Engineering has student's club named 'Pinnacle Club'. Students of second, third and final year of department can be granted membership on request. Similarly one may cancel the membership of club. First node is reserved for president of club and last node is reserved for secretary of club. Write C++ program to maintain club member's information using singly linked list. Store student PRN and Name. Write functions to: a) Add and delete the members as well as president or even secretary. b) Compute total number of members of club c) Display members d) Two linked lists exists for two divisions. Concatenate two lists.
20	The ticket booking system of Cinemax theater has to be implemented using C++ program. There are 10 rows and 7 seats in each row. Doubly circular linked list has to be maintained to keep track of free seats at rows. Assume some random booking to start with. Use array to store pointers (Head pointer) to each row. On demand a) The list of available seats is to be displayed b) The seats are to be booked c) The booking can be cancelled.
21	Write C++ program for storing appointment schedule for day. Appointments are booked randomly using linked list. Set start and end time and min and max duration for visit slot. Write functions for- A) Display free slots B) Book appointment C) Sort list based on time D) Cancel appointment (check validity, time bounds, availability) E) Sort list based on time using pointer manipulation
22	Second year Computer Engineering class, set A of students like Vanilla Ice-cream and set B of students like butterscotch ice-cream. Write C++ program to store two sets using linked list. compute and display- a) Set of students who like both vanilla and butterscotch b) Set of students who like either vanilla or butterscotch or not both c) Number of students who like neither vanilla nor butterscotch
23	Write C++ program for storing binary number using doubly linked lists. Write functions- a) To compute 1's and 2's complement b) Add two binary numbers
24	Write C++ program to realize Set using Generalized Liked List (GLL) e.g. A ={ a, b, {c, d,e, { }, {f,g}, h, I, {j,k}, l, m}. Store and print as set notation.
	Group D
25	A palindrome is a string of character that's the same forward and backward. Typically, punctuation, capitalization, and spaces are ignored. For example, "Poor Dan is in a droop" is a palindrome, as can be seen by examining the characters "poor danisina droop" and observing that they are the same forward and backward. One way to check for a palindrome is to reverse the characters in the string and then compare with them the original-in a palindrome, the sequence will be identical. Write C++ program with functions- a) To print original string followed by reversed string using stack b) To check whether given string is palindrome or not
26	In any language program mostly syntax error occurs due to unbalancing delimiter such as (),{},[]. Write C++ program using stack to check whether given expression is well parenthesized or not.

27	Implement C++ program for expression conversion as infix to postfix and its evaluation using stack based on given conditions: 1. Operands and operator, both must be single character. 2. Input Postfix expression must be in a desired format. 3. Only '+', '-', '*' and '/ ' operators are expected.
28	A classic problem that can be solved by backtracking is called the Eight Queens problem, which comes from the game of chess. The chess board consists of 64 square arranged in an 8 by 8 grid. The board normally alternates between black and white square, but this is not relevant for the present problem. The queen can move as far as she wants in any direction, as long as she follows a straight line, Vertically, horizontally, or diagonally. Write C++ program with recursive function for generating all possible configurations for 4-queen's problem.
	Group E
29	Queues are frequently used in computer programming, and a typical example is the creation of a job queue by an operating system. If the operating system does not use priorities, then the jobs are processed in the order they enter the system. Write C++ program for simulating job queue. Write functions to add job and delete job from queue.
30	Write program to implement a priority queue in C++ using an inorder list to store the items in the queue. Create a class that includes the data items (which should be template) and the priority (which should be int). The inorder list should contain these objects, with operator <= overloaded so that the items with highest priority appear at the start of the list (which will make it relatively easy to retrieve the highest item.)
31	A double-ended queue (deque) is a linear list in which additions and deletions may be made at either end. Obtain a data representation mapping a deque into a one-dimensional array. Write C++ program to simulate deque with functions to add and delete elements from either end of the deque.
32	Pizza parlor accepting maximum M orders. Orders are served in first come first served basis. Order once placed cannot be cancelled. Write C++ program to simulate the system using circular queue using array.
	@The CO-PO Mapping Matrix

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	1	-	-	-	-	-	-	-	-
CO2	2	2	2	1	-	-	-	-	-	-	-	-
CO3	-	2	1	1	-	-	-	-	-	-	-	-
CO4	1	2	2	1	-	-	-	-	-	-	-	-

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Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217523: OOP and Computer Graphics Laboratory

Teaching Scheme Practical: 04 Hours/Week	Credit Scheme 02	Examination Scheme and Marks Term Work: 25 Marks Practical: 25Marks

Companion Course: 210243: Object Oriented Programming(OOP), 210244: Computer Graphics

Course Objectives:

To understand basics of Computer Graphics, apply various methods and techniques for implementing line-circle drawing, projections, animation, shading, illumination and lighting using concepts of Object Oriented Programming.

Course Outcomes:

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

CO1: **U**nderstand and **apply** the concepts like inheritance, polymorphism, exception handling and generic structures for implementing reusable programming codes.

CO2: **Analyze** the concept of file and **apply** it while storing and retrieving the data from secondary storages.

CO3: **Analyze** and **apply** computer graphics algorithms for line-circle drawing, scan conversion and filling with the help of object oriented programming concepts.

CO4: **Understand** the concept of windowing and clipping and **apply** various algorithms to fill and clip polygons.

CO5: **Apply** logic to implement, curves, fractals, animation and gaming programs.

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software and Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. 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 must be avoided. Use of DVD containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory.

Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student. Each Laboratory assignment assessment will assign grade/marks based on parameters, such as timely completion, performance, innovation, efficient codes, and punctuality.

Guidelines for Practical Examination

Problem statements must be decided by the internal examiner in consultation with the external examiner. During practical assessment, maximum weightage should be given to satisfactory implementation of the problem statement. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals, effective and efficient implementation. The questions asked will in no way be the deciding factor for passing the students. This will encourage, transparent evaluation and fair approach, and hence 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 student's academics.

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. Use of open source software is encouraged. Based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

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

Programming tools recommended: - Open Source C++ Programming tool like G++/GCC, OPENGL.
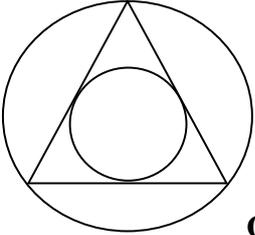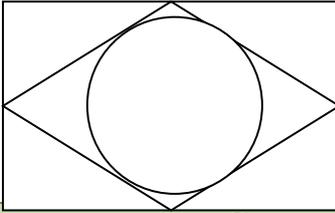
Virtual Laboratory:

- http://cse18- iiith.vlabs.ac.in/Introduction.html?domain=Computer%20Scie nce
- http://vlabs.iitb.ac.in/vlabs-dev/labs/cglab/index.php

Part I : Object Oriented Programming

Suggested List of Laboratory Experiments/Assignments
(All assignments are compulsory)

Sr. No.	Group A
	Group A
1	Implement a class Complex which represents the Complex Number data type. Implement the following 1. Constructor (including a default constructor which creates the complex number 0+0i). 2. Overload operator+ to add two complex numbers. 3. Overload operator* to multiply two complex numbers. 4. Overload operators << and >> to print and read Complex Numbers.
2	Develop a program in C++ to create a database of student's information system containing the following information: Name, Roll number, Class, Division, Date of Birth, Blood group, Contact address, Telephone number, Driving license no. and other. Construct the database with suitable member functions. Make use of constructor, default constructor, copy constructor, destructor, static member functions, friend class, this pointer, inline code and dynamic memory allocation operators-new and delete as well as exception handling.
3	Imagine a publishing company which does marketing for book and audio cassette versions. Create a class publication that stores the title (a string) and price (type float) of publications. From this class derive two classes: book which adds a page count (type int) and tape which adds a playing time in minutes (type float). Write a program that instantiates the book and tape class, allows user to enter data and displays the data members. If an exception is caught, replace all the data member values with zero values.
	Group B
4	Write a C++ program that creates an output file, writes information to it, closes the file, open it again as an input file and read the information from the file.
5	Write a function template for selection sort that inputs, sorts and outputs an integer array and a float array.
	Group C
6	Write C++ program using STL for sorting and searching user defined records such as personal records (Name, DOB, Telephone number etc) using vector container. **OR** Write C++ program using STL for sorting and searching user defined records such as Item records (Item code, name, cost, quantity etc) using vector container.
7	Write a program in C++ to use map associative container. The keys will be the names of states and the values will be the populations of the states. When the program runs, the user is prompted to type the name of a state. The program then looks in the map, using the state name as an index and returns the population of the state.

	Part II : Computer Graphics
Sr. No.	**Group A**
	Suggested List of Laboratory Experiments/Assignments (**All assignments are compulsory**)
Sr. No.	**Group A**
1.	Write C++ program to draw a concave polygon and fill it with desired color using scan fill algorithm.
2.	Write C++ program to implement Cohen Southerland line clipping algorithm.
3.	a) Write C++ program to draw the following pattern. Use DDA line and Bresenham's circle drawing algorithm. Apply the concept of encapsulation. **OR** b) Write C++ program to draw the following pattern. Use DDA line and Bresenham's circle drawing algorithm. Apply the concept of encapsulation.
	Group B
4.	a) Write C++ program to draw 2-D object and perform following basic transformations: 1. Scaling 2. Translation 3. Rotation. Apply the concept of operator overloading. **OR** **b)** Write C++ program to implement translation, rotation and scaling transformations on equilateral triangle and rhombus. Apply the concept of operator overloading.
5.	a) Write C++ program to generate snowflake using concept of fractals. **OR** b) Write C++ program to generate Hilbert curve using concept of fractals. **OR** c)Write C++ program to generate fractal patterns by using Koch curves.
	Group C
6.	a) Design and simulate any data structure like stack or queue visualization using graphics. Simulation should include all operations performed on designed data structure. Implement the same using OpenGL. **OR** b) Write C++ program to draw 3-D cube and perform following transformations on it using OpenGL i) Scaling ii) Translation iii) Rotation about an axis (X/Y/Z). **OR** c) Write OpenGL program to draw Sun Rise and Sunset.

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7.	a) Write a C++ program to control a ball using arrow keys. Apply the concept of polymorphism. **OR** b) Write a C++ program to implement bouncing ball using sine wave form. Apply the concept of polymorphism. **OR** c) Write C++ program to draw man walking in the rain with an umbrella. Apply the concept of polymorphism. **OR** Write a C++ program to implement the game of 8 puzzle. Apply the concept of polymorphism. **OR** d) Write a C++ program to implement the game Tic Tac Toe. Apply the concept of polymorphism.

Mini- Project

8.	Design and implement game / animation clip / Graphics Editor using open source graphics library. Make use of maximum features of Object Oriented Programming.

@The CO-PO Mapping Matrix

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	1	2	1	-	-	-	-	-	-	-	-
CO2	-	1	2	1	-	-	-	-	-	-	-	-
CO3	2	1	1	-	-	-	-	-	-	-	-	-
CO4	1	2	2	1	-	-	-	-	-	-	-	-
CO5	-	2	2	1	-	-	-	-	-	-	-	-
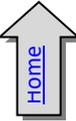
Home

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) 217524: Operating Systems Laboratory		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 Hours/Week	**01**	**Term Work (TW): 25 Marks**

Prerequisite Courses: **110005:** Programming and Problem Solving

Companion Course: 217525: Operating Systems

Course Objectives:
- To learn and understand process, resource and memory management
- To understand shell scripting and shell programming

Course Outcomes:
On completion of the course, learner will be able to–
CO1: Choose the best CPU scheduling algorithm for a given problem instance
CO2: Demonstrate interprocess communication
CO3: Apply deadlock avoidance algorithm
CO4: Compare performance of page replacement algorithms
CO5: Demonstrate the fundamental UNIX commands & system calls

All assignments from Group A are compulsory, any three from Group B and any one from Group C

List of Assignments

Group A

1. Given the list of processes, their CPU burst times. Display/print the Gantt chart for FCFS , SJF , Priority and Round Robin scheduling algorithm. Compute and print the average waiting time and average turnaround time

2. Implement producer-consumer problem with counting semaphores and mutex

3. Demonstrate Reader-Writer problem with reader priority or writer

4. Write a program to implement the Bankers Algorithm.

5. Write a program to implement page Replacement strategies (FIFO, LRU,Optimal)

6. Write a Program to implement paging simulation using Least Recently Used (LRU) and Optimal algorithm

Group B

1. Implement UNIX system calls like ps, fork, join, exec family, and wait for process management (use shell script/ Java/ C programming)Shell programming

2. Write a program to implement an address book with options given below: a) Create address book. b) View address book. c) Insert a record. d) Delete a record. e) Modify a record. f) Exit

3. Create a shell program to do mathematical operations.

4. Create a shell program to find string in a file using grep system call.

Group C

1. Inter process communication in Linux using Pipes
   Pipes: Full duplex communication between parent and child processes. Parent process writes a pathname of a file (the contents of the file are desired) on one pipe to be read by child process and child process writes the contents of the file on second pipe to be read by parent process and displays on standard output.

2. Inter process communication in Linux using FIFO

FIFOs: Full duplex communication between two independent processes. First process accepts sentences and writes on one pipe to be read by second process and second process counts number of characters, number of words and number of lines in accepted sentences, writes this output in a text file and writes the contents of the file on second pipe to be read by first process and displays on standard output.

Learning Resources

Text Books:

1. 1. Das, Sumitabha, UNIX Concepts and Applications, TMH, ISBN-10: 0070635463, ISBN-13: 978-0070635463, 4th Edition.
2. Kay Robbins and Steve Robbins, UNIX Systems Programming, Prentice Hall, ISBN-13: 9780134424071, ISBN-10: 0134424077, 2nd Edition
3. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, WILEY, ISBN978-1-118-06333-0, 9th Edition

Reference Books:

4. Mendel Cooper, Advanced Shell Scripting Guide, Linux Documentation Project, Public domain.
5. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, ISBN-10: 0-13-380591-3, ISBN-13: 978-0-13-380591-8, 8th Edition
6. Andrew S. Tanenbaum & Herbert Bos, Modern Operating System, Pearson, ISBN-13: 9780133592221, 4th Edition

e-Books:

1. https://tecmint.tradepub.com/free/w_wile48/prgm.cgi?a=1
2. https://tecmint.tradepub.com/free/w_pack42/prgm.cgi?a=1
3. https://repository.dinus.ac.id/docs/ajar/Operating_System.pdf

MOOC Courses:

https://nptel.ac.in/courses/106/105/106105214/

@The CO-PO mapping table

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	3	2	-	-	2	1	1	-	2
CO2	3	2	-	3	2	-	-	2	1	1	-	2
CO3	3	2	-	3	2	-	-	2	1	1	-	2
CO4	3	2	-	2	2	-	-	2	1	1	-	2
CO5	3	2	1	-	2	-	-	2	1	-	-	2

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217525: Business Communication Skills

Teaching Scheme **Practical: 02 Hours/Week**	**Credit Scheme** **01$**	**Examination Scheme and Marks** **Term Work$: 25 Marks**

Course Objectives:
- To facilitate Holistic growth ;
- To make the engineering students aware, about the importance, the role and the content of business communication skills ;
- To develop the ability of effective communication through individual and group activities;
- To expose students to right attitudinal and behavioural aspects and to build the same through various activities;

Course Outcomes:

On completion of the course, learner will be able to–
- **CO1:** **Express** effectively through verbal/oral communication and improve listening skills
- **CO2:** **Write** precise briefs or reports and technical documents.
- **CO3:** **Prepare** for group discussion / meetings / interviews and presentations.
- **CO4:** **Explore** goal/target setting, self-motivation and practicing creative thinking.
- **CO5:** **Operate** effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership qualities.

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal and Term Work Assessment

The student must prepare the journal in the form of report elaborating the activities performed. Continuous assessment of laboratory work is to be done based on overall performance and performance of student at each assignments. Each Laboratory assignment assessment will assign grade/marks based on parameters with appropriate weightage.

Suggested parameters for overall assessment as well as each Laboratory assignment assessment include- timely completion of assignment, performance, punctuality, neatness, enthusiasm, participation and contribution in various activities- SWOT analysis, presentations, team activity, event management, group discussion, Group exercises and interpersonal skills and similar other activities/assignments and Well presented, timely and complete report.

Recommended Assessment and Weightage Parameters:

(Attendance 30%, Assignments/activities-Active participation and proactive learning 50% and report 20%)

Students must submit the report of all conducted activities conducted. The brief guidelines for report preparations are as follows:
1. One activity report must be of maximum 3 pages;
2. Combined Report of all activities with cover pages, table of contents and certificate (signed by instructor) is to be submitted in soft copy (pdf) format only.
3. The report must contain:
- General information about the activity;
- Define the purpose of the activity;
- Detail out the activities carried out during the visit in chronological order;
- Summarize the operations / process (methods) during the activities;
- Describe what you learned (outcomes) during the activities as a student;

Guidelines for Laboratory Conduction

The instructor may frame assignments to enhance skills supporting career aspects. Multiple set of activity based assignments can be prepared and distributed among batches.

Every student must be given adequate opportunity to participate actively in each activity. An exercise can be designed to allow multiple skills exposure for example a group task encouraging discussions, team building, value sharing, leadership and role play all at the same time.

MOOC at Swayam:$
https://swayam.gov.in/nd2_imb19_mg14/preview

Virtual Laboratory:
- https://ve-iitg.vlabs.ac.in/

Sr. No.	Suggested List of Laboratory Experiments/Assignments
1	**SWOT analysis** The students should be made aware of their goals, strengths and weaknesses, attitude, moral values, self-confidence, etiquettes, non-verbal skills, achievements. through this activity. SWOT Analysis, Confidence improvement, values, positive attitude, positive thinking and self-esteem. The concern teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects
2	**Personal and Career Goal setting – Short term and Long term** The teacher should explain to them on how to set goals and provide template to write their short term and long term goals.
3	**Public Speaking** Any one of the following activities may be conducted : **1. Prepared speech** (Topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver.) **2. Extempore speech (**Students deliver speeches spontaneously for 5 minutes each on a given topic) **3. Story telling** (Each student narrates a fictional or real life story for 5 minutes each) **4. Oral review** (Each student orally presents a review on a story or a book read by them)
4	**Reading and Listening skills** The batch can be divided into pairs. Each pair will be given an article (any topic) by the teacher. Each pair would come on the stage and read aloud the article one by one. After reading by each pair, the other students will be for correct answers and also for their reading skills. This will evaluate their reading and listening skills. The teacher should give them guidelines on improving their reading and listening skills. The teacher should also give passages asked questions on the article by the readers. Students will get marks on various topics to students for evaluating their reading comprehension.
5	**Group discussion** Group discussions could be done for groups of 5-8 students at a time Two rounds of a GD for each group should be conducted and teacher should give them feedback.
6	**Letter/Application writing** Each student will write one formal letter, and one application. The teacher should teach the students how to write the letter and application. The teacher should give proper format and layouts.
7	**Report writing** The teacher should teach the students how to write report .The teacher should give proper format and layouts. Each student will write one report based on visit / project / business proposal.
8	**Resume writing-** Guide students and instruct them to write resume
9	**Presentation Skill** Students should make a presentation on any informative topic of their choice. The topic may be technical or non-technical. The teacher should guide them on effective presentation skills. Each student should make a presentation for at least 10 minutes.
10	**Team games for team building -** Students should make to participate in team activity.

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11	**Situational games for role playing as leaders**
12	**Faculty may arrange one or more sessions from following:** Yoga and meditation. Stress management, relaxation exercises, and fitness exercises. Time management and personal planning sessions.
13	**Mock interviews-** guide students and conduct mock interviews
14	**Telephonic etiquettes** -To teach students the skills to communicate effectively over the phone. Students will be divided into pairs. Each pair will be given different situations, such as phone call to enquire about job vacancy, scheduling a meeting with team members, phone call for requesting of urgent leave from higher authorities. Students will be given 10 min to prepare. Assessment will be done on the basis of performance during the telephone call.
15	**Email etiquettes** -To provide students with an in-depth understanding of email skills. Students will be made to send e-mails for different situations such as sending an e-mail to the principal for a leave, inviting a friend for a party, e-mail to enquire about room tariff of a hotel. Students will be assessed on the basis of e-mail such as clarity, purpose and proof reading of e-mail.

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	2	-	-
CO2	-	-	-	-	-	-	-	-	-	2	1	-
CO3	-	-	-	-	-	-	-	-	2	-	-	1
CO4	-	-	-	-	-	-	-	-	-	2	-	2
CO5	-	-	-	-	-	-	-	-	3	-	-	2

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) 217526: Humanity and Social Science			Home
Teaching Scheme	**Credit Scheme**	**Examination Scheme and Marks**	
Tutorial: 01 Hours/Week	**01$**	**Term work$:** **25 Marks**	

Course Objectives:

To enable the students to explore aspects of human society and to acquire the intellectual, communication skills and develop characteristics that encourages personal fulfilment, meaningful professional life and responsible citizenship.

- To facilitate Holistic growth;
- To Educate about Contemporary, National and International affairs;
- To bring awareness about the responsibility towards society.
- To give an insight about the emergence of Indian society and the relevance of Economics.

Course Outcomes:

On completion of the course, learner will be–

CO1: **Aware** of the various issues concerning humans and society.

CO2: **Aware** about their responsibilities towards society.

CO3: Sensitized about broader issues regarding the social, cultural, economic and human aspects, involved in social changes.

CO4: **Able** to understand the nature of the individual and the relationship between self and the community.

CO5: **Able** to understand major ideas, values, beliefs, and experiences that have shaped human history and cultures.

Course Contents

Preamble:

As applied sciences, Engineering and Technology are meant to come up with effective solutions to social problems making it imperative that the present generation of engineers and technologists understand the society they live in. Studying the social sciences can provide individuals with crucial answers and observations that could certainly help in understanding of one's life which can alleviate social relations. A broad perspective of nationalistic thinking will provide the students with the ability to be socially conscientious, more resilient and open to building an inclusive society.

Experiencing real-life situations and complex scenarios that arise in each situation will help the budding professions to contribute their skills and knowledge to helping people improve and understand their behaviour or psychological processes. Understanding how the world works begins with an understanding of oneself and gaining hands-on experience and/or thinking about human values and ethics will help trigger a sense of responsibility among the students and lead them to finding effective solutions.

Course Structure: The tutorial sessions to be divided into 2 groups

1. Interactive Sessions to be conducted in classroom
2. Interactive Activities to be conducted Outside Classroom

MOOC/ Video Lectures available at$:

- https://nptel.ac.in/courses/109/103/109103023/
- https://nptel.ac.in/courses/109/107/109107131/

- Teachers will play the role of interventionists and instigating students to apply their thinking abilities on social concepts
- As facilitators and mentors teachers will coax the students to thinking out-of-the-box to come up with creative solutions
- Teachers should focus on instilling a sense of social consciousness through the activities conducted indoors and outdoors.

Change of Mindset

- Since the course deviates from technical subjects, students will have to be counseled into the
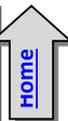
importance of social sciences
- A background understanding of the importance of this course in their professional and personal life will have to be enumerated to the students
- Teachers will have to rationalize the course outcomes to get the students invested in the activities being conducted

Designing of Course
- Since students lack prior knowledge, it is imperative that the tutorials conducted be engaging in its activities
- Focus of the sessions should be the learning outcome of each activity conducted either in the class or outside the class
- All activities designed should be as close to real-life making them relatable and applicable
- Student-engagement should be a priority so that the knowledge internalized will be higher
- The activities chosen can be modified to cater to the college location and social context
- The learning should be focused on application of ethics and values during each activity
- The chosen sessions should cater to giving the students the opportunity to be involved and engaged in their role as contributors to society and the nation at large

Basic function of the tutor
- To present a holistic view of the curriculum and the role of this course in it and emphasizing the benefit of the sessions towards developing communications kills, critical thinking and problems solving

Grouping
- The class will be divided into groups of 20 students
- The blend of cultural and social diversity will enhance the learning at the end of each activity
- Teachers will have to be mentored to handle sensitive issues diplomatically while encouraging students to stand up for their beliefs
- The groups will have to have inter-personal sessions so that they get to understand their team members better and work cohesively
- Management support and encouragement to engage students in life-enriching experiences is important

Assessment of Learning
- It is important for tutors to make sure that assessment is consistent with learning objectives of each activity
- Assessment of students should be focused on the students' ability to internalize the learning
- Tutors need to understand meaningful ways of assessing students' work to motivate learning

Tutorial Conduction and Term Work guidelines

Interactive Sessions to be conducted during Tutorial (in classroom)

1. PREPARED SPEECH ON CURRENT AFFAIRS
   a. Purpose – Get students to stay abreast and invested in national current affairs
   b. Method – Each student has to read an editorial from any national paper (English), find out more information on the topic and present it to the class; ending the session with his/her opinion on the matter
   c. Outcome – Awareness of national state of affairs. Improve on oratory skills. Instil the thinking and contemplative skills and form non-judgmental opinions about an issue

2. UNDERSTANDING INDIA'S CULTURAL DIVERSITY
   a. Purpose – Expose students to the intricacies of Indian cultural across various states
   b. Method – Each student (or a small group of students in case the number of students is large) has to pick a state and come to the tutorial session prepared with a PPT that will showcase the demographic, sociographic and cultural information of that state
   c. Outcome – Information about the beauty of Indian cultural diversity. Enhance exploratory skill, communication skills and learn to present using technological tools.

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3. WRITING AN ARTICLE ON ANY SOCIAL ISSUE
   a. Purpose – Highlight various social and cultural evil malevolence existing in our country and express one's opinion on how it can be changed
   b. Method – Each student will have to write a 200 word essay on any of existing social malice that is prevalent in society. On evaluation, the top 5 essays can be displayed on the college wall magazine and rewarded if deemed appropriate
   c. Outcome – Learn to raise one's voice against the wrong doings in communities. Build writing skills, improve language and gain knowledge about how to write an impactful essay

4. GROUP DISCUSSION ON COMMUNAL TOPIC
   a. Purpose – Make students aware of the issues that are pertinent in a society and express a learned opinion about it
   b. Method – Students in groups of 20 each will discuss a relevant and grave issue that is dogging the nation. Alternatively, topics from current affairs (National budget, democratic process, economical strengthening of the country).
   c. Outcome – Develop group communication skills. Learn to speak up one's opinion in a forum. Cultivate the habit of presenting solution-driven arguments making them contributors in any team

5. QUIZ ON SOCIAL BEHAVIOR
   a. Purpose – Augment proper social etiquette among students and make them responsible citizens
   b. Method – Conduct a quiz on traffic rules using audio-visual aids or using dumb charades where one student has to enact the traffic rule and the others have to guess that rule
   c. Outcome – Grasp of various traffic rules and driving etiquette. Build verbal and non-verbal communication skills

6. SCREEN A MOVIE (FOCUS ON POSITIVITY AND POWER OF THE MIND)
   a. Purpose – Expose students to introspective skills and try to develop a positive thinking in life
   b. Method – Screen a movie / a documentary / a video that focuses on the power of the mind and how to create affirmations in one's life. At the end of the movie, students can be asked to express their opinions and write down what changes / improvements they plan to take in their choices thereafter. This can be followed by a guest lecture by expert/s or workshop
   c. Outcome – Comprehend the areas of improvement within themselves. Understand the importance of staying positive and develop affirmations

7. QUIZ ON SOCIAL BEHAVIOR
   a. Purpose – Augment proper social etiquette among students and make them responsible citizens
   b. Method – Conduct a quiz on traffic rules using audio-visual aids or using dumb charades where one student has to enact the traffic rule and the others have to guess that rule
   c. Outcome – Grasp of various traffic rules and driving etiquette. Build verbal and non-verbal communication skills

8. SCREEN A MOVIE (FOCUS ON POSITIVITY AND POWER OF THE MIND)
   a. Purpose – Expose students to introspective skills and try to develop a positive thinking in life
   b. Method – Screen a movie / a documentary / a video that focuses on the power of the mind and how to create affirmations in one's life. At the end of the movie, students can be asked to express their opinions and write down what changes / improvements they plan to take in their choices thereafter. This can be followed by a guest lecture by expert/s or workshop
   c. Outcome – Comprehend the areas of improvement within themselves. Understand the importance of staying positive and develop affirmations

9. DEBATE ON A TOPIC FROM SOCIAL SCIENCES
    a. Purpose – Educate students about various domains in social sciences and develop an interest towards gaining knowledge about these topics
    b. Method – Various topics from various domains of social sciences can be chosen and students in pairs can pick a topic and present their arguments for or against the topic. Time for each debate will be 10 minutes maximum
    c. Outcome – Recognize the significance of social sciences in our lives. Cultivate the habit to present forceful arguments while respecting the opponents perspective and enhance verbal skills.

Interactive Activities to be conducted during Tutorial (Outside Classroom)

1. WASTE MANAGEMENT and CLEAN CAMPUS
    a. Purpose: Create awareness among students about the significance of a clean environment and social responsibility to deter littering and segregate waste
    b. Method: Students (in groups) will be given charge of areas of campus and will be expected to clean that segment. Also, they will be entrusted with the responsibility to collect, separate waste and hand over to the housekeeping authority
    c. Outcome: Develop the habit to maintain cleanliness at home as well as learn to respect community areas at college or workplace. It will also encourage them become ambassadors among their peers to advocate protection of the environment

2. MAKING A VIDEO ON SOCIAL WASTAGES.
    a. Purpose: Instil among students a sense of responsibility towards judiciously using natural resources like water and electricity
    b. Method: Using their phones / hand-held devices, groups of students will make a 3 – 4 minute short film that will highlight irresponsible behavior in terms of wastage of water, leaving lights, fans and other electrical appliances on when not in use, defacing public and campus property by scribbling on walls and common areas. They will make awareness for the same among students. The creative videos will be posted on the college website and social media as an encouragement
    c. Outcome: Conscientious behavior towards saving public utility resources. Explore the use of audio-visual tools to create more meaningful messages that can effect a change in society

3. RELAY MARATHON (3 – 5 kms)
    a. Purpose: Propagate a social message by way of a sport activity
    b. Method: A group of students will begin the race with banner / placard in hand that contains a social message. The group runs for 500 meters and hands over the banner / placard to the next group of students. This chain of exchange will continue for 3 – 5 kms.
    c. Outcome: Become aware of the need for fitness and encouragement towards healthier lifestyle. Students will also be able to express their creativity in terms of meaningful messages and gain attention towards worthy social causes from the community in and around the campus.

4. TREE PLANTATION ON CAMPUS
    a. Purpose: Involve students to actively participate in environment protection and develop greener surroundings
    b. Method: Each student will plant a sapling and take care of that plant until it is able to sustain itself. Alternatively, students can organize a tree plantation drive in a public area and nurture it
    c. Outcome: Besides increase in plants in the locality, students will feel a sense of empowerment and become social contributors towards protecting the environment.

5. VISIT TO AN OLD AGE HOME / ORPHANAGE
    a. Purpose: Build a sense of responsibility towards the less fortunate in our society and feel privileged to be able to effect real change in the world around us
    b. Method: Students have to visit an old age home or orphanage in the vicinity of the college. They can interact with the inmates, probably donate utilities to the charity organization and/or probably stage a few inclusive activities with the residents of the place. After the visit, students can submit a brief report about their experience
    c. Outcome: Learn first-hand about the conditions and social situations that the no-so-privileged members of our society have to endure to survive and go beyond their

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embarrassment to interact with the destitute which will help students appreciate the importance of Indian family values

6. STREET PLAY ACTIVITY
   a. Purpose: Create awareness in themselves as well as people in the community on various social evils that need to be eradicated
   b. Method: Students will prepare and enact a street play on any pertinent issues in society. The topics suggested can be perils of mobile phones / online fraud / safety for girls / mental and physical health of the youth.
   c. Outcome: Allow students to deliberate and think deeply about the looming issues that is dogging our society and the future of the youth. This will also bring out the creative skills among the students and allow them to showcase their talent.

7. BUDDY / BIG BROTHER SYSTEM
   a. Purpose: Include and involve the less fortunate children making them feel wanted and cared for as well as use the opportunity to share knowledge among school students.
   b. Method: Students have to go to nearby schools after procuring appropriate permissions to teach a particular topic on either technical or non technical domains. Each student can choose to adopt 5 students from the class to be their mentor over a period of 1 year by staying in touch with them and helping them resolve their issues on academic or other matters.
   c. Outcome: Appreciation and respect towards the responsibility of teaching. They will learn to be accountable as social contributors and bring about some change in the lives of the young students they mentor as Buddies or Big Brother.

Term Work Assessment Guidelines

Students must submit the report of all conducted activities conducted during Tutorial (Outside Classroom) of at least 04 activities (out of 07 activities) from 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. Combined Report of all activities with cover pages, table of contents and certificate (signed by instructor) is to be submitted in soft copy (pdf) format only.

3. The report must contain:
   - General information about the activity;
   - Define the purpose of the activity;
   - Detail out the activities carried out during the visit in chronological order;
   - Summarize the operations / process (methods) during the activities;
   - Describe what you learned (outcomes) during the activities as a student;
   - Add photos of the activity;(optional)
   - Add a title page to the beginning of your report;
   - Write in clear and objective language; and
   - Get well presented, timely and complete report submitted.

Recommended Assessment and Weightage Parameters:

(Attendance 30%, Assignments/Activities-Active participation and proactive learning 50% and report 20%)

Learning Resources

Books:

1. A. Alavudeen, M. Jayakumaran, and R Kalil Rahman, "Professional Ethics and Human Values"
2. Ram Ahuja, "Social Problems in India" (third edition)
3. Shastry, T. S. N., "India and Human rights: Reflections", Concept Publishing Company India Pvt. Ltd., 2005.
4. Nirmal, C.J., "Human Rights in India: Historical, Social and Political Perspectives (Law in India)", Oxford India
5. Rangarajan, "Environmental Issues in India", Pearson Education.
6. University of Delhi, The Individual and Society, Pearson Education.
7. Wikipedia.org / wiki /social studies.
8. M. N. Srinivas, "Social change in modern India", 1991, Orient Longman.
9. David Mandelbaum, Society in India, 1990, Popular.
10. Dr. Abha Singh, "Behavioral Science: Achieving Behavioral Excellence for Success", Wiley.

e-Books:

- https://www.moteoo.org/en/products/social-science-and-humanities-student-book-english
- https://www.springeropen.com/books
  (SpringerOpen open access books; download them free of charge from SpringerLink)
- https://muse.jhu.edu/article/541846/pdf
  (This content has been declared *free* to read by the publisher during the COVID-19)

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	2	2	2	-	-	-
CO2	-	-	-	-	-	-	2	-	-	-	-	-
CO3	-	-	-	-	-	-	-	2	2	-	-	1
CO4	-	-	-	-	-	-	2	2	2	-	-	-
CO5	-	-	-	-	-	-	-	2	-	-	-	-
CO6	-	-	-	-	-	-	-	-	-	-	-	-

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217527: Audit Course 3

In addition to credits, it is recommended that there should be audit course, in preferably in each semester starting from second year in order to supplement students' knowledge and skills. Student will be awarded the bachelor's degree if he/she earns specified total credit [1] and clears all the audit courses specified in the curriculum. The student will be awarded grade as AP on successful completion of audit course. The student may opt for one of the audit courses per semester, starting in second year first semester. Though not mandatory, such a selection of the audit courses helps the learner to explore the subject of interest in greater detail resulting in achieving the very objective of audit course's inclusion. List of options offered is provided. Each student has to choose one audit course from the list per semester. Evaluation of audit course will be done at institute level itself. Method of conduction and method of assessment for audit courses are suggested.

Criteria:

The student registered for audit course shall be awarded the grade AP (Audit Course Pass) and shall be included such AP grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself [1]

Guidelines for Conduction and Assessment (Any one or more of following but not limited to):

- Lectures/ Guest Lectures
- Visits (Social/Field) and reports
- Demonstrations

- Surveys
- Mini-Project
- Hands on experience on focused topic

Course Guidelines for Assessment (Any one or more of following but not limited to):

- Written Test
- Demonstrations/ Practical Test
- Presentations, IPR/Publication and Report

Audit Course 3 Options

Audit Course Code	Audit Course Title
217527-I	Green Construction and Design
217527-II	Social Awareness and Governance Program
217527-III	Environmental Studies
217527-IV	Smart Cities
217527-V	Foreign Language (one of Japanese/Spanish/French/German). Course contents for **Japanese(Module 1)** are provided. For other languages institute may design suitably.

Note: It is permitted to opt one of the audit courses listed at SPPU website too, if not opted earlier.
http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202017/Forms/AllItems.aspx
http://www.unipune.ac.in/university_files/syllabi.htm

Savitribai Phule Pune University **Second Year of Artificial Intelligence and Data Science (2020 Course)** **217527-I: Green Construction and Design**	

Prerequisites: General awareness of environment and eco system.

Course Objectives:
1. To motivate students for undertaking green construction projects, technical aspects of their design, obstacles to getting them done, and future directions of the field.
2. To increase awareness of green construction issues, so that students will know the range of existing knowledge and issues.
3. Proper use of energy, water and other resources without harming environment.
4. To reduce waste pollution and Environment Degradation.

Course Outcomes:
On completion of the course, learner will be able to–
CO1: **Understand** the importance of environment friendly society.
CO2: **Apply** primary measures to reduce carbon emissions from their surroundings.
CO3: **Learn** role of IT solutions in design of green buildings.
CO4: **Understand** the use of software systems to complete statutory compliances involved in the design of a new home or office building through green construction.

Course Contents

1. Introduction to Green Construction, need of green construction, Importance, Government Initiatives, your role in the Green Environment.
2. How to do Green Construction, Project Definition, Team Building, Education and Goal Setting, Documents and Specification.
3. Elements of Green Construction, Materials Construction Waste Management, Indoor Air Quality, Energy Efficiency.
4. Indian Green Building Council (IGBC), Introduction to IGBC, IGBC rating system, Green building projects in India, Benefits of green building, effects on natural resources.

Team Projects:

Students will be formed into groups to research green construction and design in a particular construction context and report their results to the class. What are the particular obstacles and opportunities to integrating green construction techniques into the following sectors? Be sure to consider technical, social, political and economic issues:

Hotels (economy, luxury, resorts), Hospitals, Retail(big box, malls, small scale downtown retail), Office, Government, ,Schools, Universities, Housing, Transportation Stations (Airport Terminals, Train Stations).

References :

1. Kibert, C. (2008) Sustainable Construction: Green Building Design and Delivery, 2nd edition(Hoboken, NJ: John Wiley and Sons.
2. Handbook of Green Building Design and Construction 1st Edition, by Sam Kubba, eBook ISBN:9780123851291.

IGBC Green New Buildings Rating System, Version 3.0, Abridged Reference Guide September 2014.
Available:https://igbc.in/igbc/html_pdfs/abridged/IGBC%20Green%20New%20Buildings%20Rating%20System%20(Version%203.0).pdf

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	2	-	-	3	3	-	-	-	-	-
CO2	-	-	2	-	-	3	3	-	-	-	-	-
CO3	-	-	-	-	3	-	2	-	-	-	-	-
CO4	-	-	1	-	3	-	2	-	-	-	-	-

Savitribai Phule Pune University

Second Year of Artificial Intelligence and Data Science (2020 Course)
217527-II: Social Awareness and Governance Program

Prerequisites:

Awareness about basic terms in Social Science and Governance

Course Objectives:
1. To Increase community awareness about social issues and to promote the practice of good governance in both private and public institutions, through policy advocacy and awareness creation in order to ensure proper utilization of public resources and good service delivery.
2. Increase community awareness on health, education, and human rights.
3. Transferring costs of social activities to other various segments of society.
4. To enhance youth participation in decision-making, democracy and economic development.

Course Outcomes:

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

CO1: **Understand** social issues and responsibilities as member of society.

CO2: **Apply** social values and ethics in decision making at social or organizational level

CO3:**Promote** obstacles in national integration and role of youth for National Integration

CO4: **Demonstrate** basic features of Indian Constitution.

Course Contents

1. Indian Society as Pluralistic, Fundamentals of unity in diversity, diversity and disparity in Indian society, women in mass media, disparities due to disability.
2. The Indian constitution as unifying factor, Introduction Making of Indian Constitution, Basic features of Indian Constitution, Strengths of Indian Constitution, and Fundamental Duties.
3. National Integration: Introduction, The Value of Tolerance, Minority Classes And Constitution, Pre-Requisites of National Integration, Obstacles To National Integration, Promotion of National Integration, Role of Youth In Promoting Communal Harmony.
4. Socialization, Ethics, Values and Prejudices, Meaning of Socialization, Functions of Socialization, Agents of Socialization, Importance of Socialization, Role of Ethics In Individual Development, Role of Basic Human Values In Individual Development, Relative Value System.

Activities:
1. Conducting training/workshops/debates on HIV/AIDS prevention and stigma reduction.
2. Public shows on girls' education and empowerment.
3. Conducting campaigns on adult/disabled education.
4. To support the government to develop policy that encourages youth participation in decision-making through government agencies.

References:
1. Devidas M. Muley , S Chand, " Social Awareness and Personality Development", ISBN: 812193074X.
2. Bhagabati Prosad Banerjee, Durga Das Basu, Shakeel Ahmad Khan, V. R. Manohar, "Introduction to the Constitution of India", ISBN : 9788180385599.

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CO2	-	-	-	-	-	-	-	3	2	-	-	-
CO3	-	-	-	-	-	-	-	2	2	-	-	-
CO4	-	-	-	-	-	-	-	1	1	-	-	-

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217527-III: Environmental Studies

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Environmental studies are the field that examines this relationship between people and the environment. An environmental study is an interdisciplinary subject examining the interplay between the social, legal, management, and scientific aspects of environmental issues.

Course Objectives:
1. Understanding the importance of ecological balance for sustainable development.
2. Understanding the impacts of developmental activities and mitigation measures.
3. Understand and realize the multi-disciplinary nature of the environment, its components, and inter-relationship between man and environment
4. Understand the relevance and importance of the natural resources in the sustenance of life on earth and living standard

Course Outcomes:
On completion of the course, learner will be able to–
  CO1: Comprehend the importance of ecosystem and biodiversity
  CO2: Correlate the human population growth and its trend to the environmental degradation and develop the awareness about his/her role towards environmental protection and prevention
  CO3: Identify different types of environmental pollution and control measures
  CO4: Correlate the exploitation and utilization of conventional and non-conventional resources

Course Contents

1. **Natural Resources:** Introduction, Renewable and non-renewable, Forest, water, mineral, food, energy and land resources, Individual and conservation of resources, Equitable use of resources.
2. **Ecosystems:** Concept, Structure, Function, Energy flow, Ecological succession, Forest, grassland, desert and aquatic ecosystems - Introduction, characteristic features, structure and function.
3. **Biodiversity:** Genetic, Species and ecological diversity, Bio Geographical classification of India, Value and hot spots, Biodiversity at global, national and local levels, India as mega-biodiversity nation, Threats to biodiversity, Endangered and endemic species of India, Conservation of Biodiversity, Endangered and endemic species, Conservation of biodiversity.
4. **Pollution:** Definition, Causes, effects and control measures of the pollution – Air, soil, Noise, Water, Marine and Thermal and Nuclear Pollution, Solid waste management, Role of Individual in Prevention of Pollution, Pollution #Exemplar/Case Studies, Disaster management

Reference:
1. Bharucha, E.,–Textbook of "Environmental Studies", Universities Press(2005),ISBN-10:8173715408
2. Mahua Basu, "Environmental Studies", Cambridge University Press, ISBN-978-1-107-5317-3

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CO2	-	-	-	-	-	3	3	-	-	-	-	1
CO3	-	2	-	-	-	2	3	-	-	-	-	-
CO4	-	-	-	-	-	2	2	-	-	-	-	-

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217527-IV: Smart Cities

We breathe in a world defined by urbanization and digital ubiquity, where mobile broadband connections outnumber fixed ones, machines dominate a new "internet of things," and more people live in cities than in the countryside. This course enables us to take a broad historical look at the forces that have shaped the planning and design of cities and information technologies from the rise
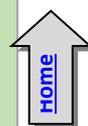
of the great industrial cities of the nineteenth century to the present. This course considers the motivations, aspirations, and shortcomings of them all while offering a new civics to guide our efforts as we build the future together, one click at a time.

Course Objectives

- To identify urban problems
- To study Effective and feasible ways to coordinate urban technologies.
- To study models and methods for effective implementation of Smart Cities.
- To study new technologies for Communication and Dissemination.
- To study new forms of Urban Governance and Organization.

Course Outcomes

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

CO1: Understand the dynamic behavior of the urban system by going beyond the physical appearance and by focusing on representations, properties and impact factors

CO2: Explore the city as the most complex human-made organism with a metabolism that can be modeled in terms of stocks and flows

CO3: Knowledge about data-informed approaches for the development of the future city, based on crowd sourcing and sensing

CO4: Knowledge about the latest research results in for the development and management of future cities

CO5: Understand how citizens can benefit from data-informed design to develop smart and responsive cities

Course Contents

Urbanization and Ubiquity - The slow emergence of learning cities in an urbanizing world. Cities as collective learners, what do we know?- Framing a view -A gamut of learning types - Secrets of knowing and accelerating change - Why some cities learn and others do not.

References:

1. Anthony M. Townsend, W. W. Nortonand Company "Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia", ISBN: 0393082873,9780393082876.
2. Tim Campbell, Routledge, "Beyond Smart Cities: How Cities Network, Learn and Innovate"‖, Routledge, ISBN:9781849714266.
3. StanGeertman, JosephFerreira, Jr.Robert Goodspeed, JohnStillwell, "Planning Support System ms and Smart Cities", Lecture notes in Geo information and Cartography, Springer.

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	2	2	-	-	2	2	1	-	-	-	-
CO2	1	2	1	-	-	1	1	-	-	-	-	-
CO3	2	1	3	3	2	-	1	-	1	1	1	
CO4	-	3	2	-	-	-	-	-	-	-	1	2

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217527-V: Foreign Language- Japanese (Module 1)

About course:

With changing times, the competitiveness has gotten into the nerves and "Being the Best"at all times is only the proof of it. Nonetheless, 'being the best' differs significantly from 'Communicating the best'! The best can merely be communicated whilst using the best… suited Language!!

Japanese is the new trend of 21st century. Not only youngsters but even the professionals seek value in it. It is the engineer's companion in current times with an assertion of a thriving future. Pune has indisputably grown to become a major center of Japanese Education in India while increasing the precedence for Japanese connoisseurs. Japanese certainly serves a great platform to unlock a notoriously tough market and find a booming career. While the companies prefer candidates having the knowledge of the language, it can additionally help connect better with the native people thus prospering in their professional journey. Learning Japanese gives an extra edge to the 'resume' since the recruiters consciously make note of the fact it requires real perseverance and self-discipline to tackle one of the most complex languages.

It would be easy for all time to quit the impossible; however it takes immense courage to reiterate the desired outcomes, recognize that improvement is an ongoing process and ultimately soldier on it. The need of an hour is to introduce Japanese language with utmost professionalism to create awareness about the bright prospects and to enhance the proficiency and commitment. It will then prove to be the ultimate path to the quest for professional excellence!

Course Objectives:
- To meet the needs of ever growing industry with respect to language support.
- To get introduced to Japanese society and culture through anguage.

Course Outcomes:

On completion of the course learner will able to-

CO1: Will have ability of basic communication.

CO2: Will have the knowledge of Japanese script.

CO3: Will get introduced to reading , writing and listening skills

CO4: Will develop interest to pursue professional Japanese Language course.

Course Contents

1. Introduction to Japanese Language. Hiragana basic Script, colors, Days of the week
2. Hiragana : modified Kana, double consonant, Letters combined with ya, yu, yoLong vowels, Greetings and expressions
3. Self Introduction, Introducing other person, Numbers, Months, Dates, Telephone numbers, Stating on'sage.

Reference:
1. Minna No Nihongo,"Japanese for Everyone", Elementary Main Text book1-1 (Indian Edition), Goyal Publishers and Distributors Pvt.Ltd.
2. http://www.tcs.com (http://www.tcs.com/news_events/press_releases/Pages/TCS-Inaugurates-Japan-centric-Delivery-Center-Pune.aspx)

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	1	3	1	1
CO2	-	-	-	-	1	-	-	-	-	3	1	1
CO3	-	-	-	-	1	-	-	-	-	3	2	2
CO4	-	-	-	-	-	-	-	-	-	1	-	1

Semester IV
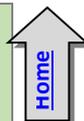
Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) 217528 : Statistics		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Lecture: 03 Hours/Week	**03**	**Mid_Semester(TH): 30 Marks** **End_Semester(TH): 70 Marks**

Prerequisite Courses: 210241: Discrete Mathematics

Companion Course: ……

Course Objectives:

- Demonstrate knowledge of probability and the standard statistical distributions.

Course Outcomes:

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

CO1: Identify the use of appropriate statistical terms to describe data

CO2: Use appropriate statistical methods to collect, organize, display, and analyze relevant data.

CO3: Use distribution functions for random variables

CO4: Distinguish between correlation coefficient and regression

CO5: Understand tests for hypothesis and its significance

Course Contents

Unit I	Introduction To Statistics And Sampling Theory	(6 Hours)

Statistics: Introduction**,** Origin and Development of Statistics, Definition, Importance and Scope, Limitations, Distrust of Statistics

Population and Sample: Sampling –Introduction, Types of Sampling, Purposive Sampling, Random Sampling, Simple Sampling, Stratified Sampling, Parameter and Statistic, Sampling Distribution,

Statistical Inference, Sampling With and Without Replacement, Random Samples: Random Numbers, Population Parameters, Sample Statistics, Sampling Distributions

#Exemplar/Case Studies.	**Case study of sampling for any real-world problem like exit poll statistics**
Mapping of Course Outcomes for Unit I	**CO1**

Unit II	Descriptive Statistics: Measures Of Central Tendency	(6 Hours)

Frequency Distributions and Measures of central Tendency: Frequency Distribution, Continuous Frequency Distribution, Graphic Representation of a Frequency Distribution, Histogram, Frequency Polygon, Averages or Measures of Central Tendency or Measures of Location, Requisites for an Ideal Measure of Central Tendency, Arithmetic Mean, Properties of Arithmetic Mean, Merits and Demerits of Arithmetic Mean, Weighted Mean, Median, Merits and Demerits of Median, Mode, Merits and Demerits of Mode, Geometric Mean, Merits and Demerits of Geometric Mean, Harmonic Mean, Merits and Demerits of Harmonic Mean, Selection of an Average

#Exemplar/Case Studies.	**Create Measures of central tendency for a real life example dataset like the payroll dataset or titanic dataset etc.**
Mapping of Course Outcomes for Unit II	CO1

Unit III	Descriptive Statistics: Measures of Dispersion	(6 Hours)

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

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

Binomial and multinomial distributions, Poisson distribution, Uniform distribution, Exponential distribution, Gaussian distribution, Log-normal distribution, Chi-square distribution

#Exemplar/Case Studies.	Create measures of dispersion for a real life example dataset like students dataset , iris detection etc
Mapping of Course Outcomes for Unit III	CO2

Unit IV	Random Variables And Probabilty Distributions	(8 Hours)

Random Variables and Distribution Functions:
Random Variable, Distribution Function, Properties of Distribution Function, Discrete Random Variable, Probability Mass Function, Discrete Distribution Function, Continuous Random Variable, Probability Density Function

Theoretical Discrete Distributions : Bernoulli Distribution, Binomial Distribution, Mean Deviation about Mean of Binomial Distribution, Mode of Binomial Distribution, Additive Property of Binomial Distribution, , Characteristic Function of Binomial Distribution, Cumulants of Binomial Distribution , Poisson Distribution, The Poisson Process, Geometric Distribution…

#Exemplar/Case Studies.	Use Binomial distribution, for the problem of reducing errors by vendors who process credit-card applications for a large credit-card bank etc.
Mapping of Course Outcomes for Unit IV	CO3

Unit V	Inferential Statistics: Hypothesis	(6 Hours)

Statistical Inference - Testing of Hypothesis, Non-parametric Methods and Sequential Analysis:
Introduction, Statistical Hypothesis (Simple and-Composite), Test of a Statistical Hypothesis, Null Hypothesis, Alternative Hypothesis, Critical Region, Two Types of Errors, level of Significance, Power of the Test

#Exemplar/Case Studies.	Hypothesis Testing for examples like: Dieters lose more fat than the exercisers, New medicine testing
Mapping of Course Outcomes for Unit V	CO4

Unit VI	Inferential Statistics: Tests For Hypothesis	(8 Hours)

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

#Exemplar/Case Studies.	Study hypothesis testing for any examples like To determine whether the female proportion of the adult population is high or any similar example
Mapping of Course Outcomes for Unit VI	**CO5**

Learning Resources

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

Reference Books:
1. Glen Cowan, " Statistical Data Analysis" , University Of Siegen, Clarendon Press, Oxford, 1998, ISBN: 0198501552
2. Ken Black, "Applied Business Statistics", Wiley, 7th Edition, ISBN: 9788126537075

e-Books:
1. https://www.itl.nist.gov/div898/handbook/
2. *https://web.stanford.edu/~hastie/ElemStatLearn/index.html*

MOOC Courses:
1. **Introduction to Probability and Statistics**
https://onlinecourses.nptel.ac.in/noc20_ma22/preview
2. **Introduction to Data Analytics**
https://nptel.ac.in/courses/110/106/110106072/

@The CO-PO mapping table

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	1	1	-	1	-	-	-	-	-	-	-	-
CO4	1	-	1	1	-	-	-	-	-	-	1	-
CO5	1	-	1	1	-	-	-	-	-	-	1	1

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217529: Internet of Things

Teaching Scheme:	Credit	Examination Scheme:
Lecture: 03 Hours/Week	03	Mid_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses:	110005: Programming and Problem Solving
Companion Course:	217531: Internet of Things Laboratory

Course Objectives:

- Understand the Basic Digital Electronics and microprocessors.
- To introduce students with the architecture and operation of typical microprocessors and microcontrollers and its interfacing
- Understand the definition and significance of the Internet of Things.
- Interface and deploy analog and digital sensors.
- To learn real world application scenarios of IoT along with its societal and economic impact using case studies.

Course Outcomes:

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

CO1: Have a thorough understanding of the structure, function and characteristics of computer systems and Understand the structure of various number systems and its application in digital design.

CO2: Develop the skill set to build IoT systems and sensor interfacing.

CO3: Explain the concept of Internet of Things and identify the technologies that make up the internet of things

CO4: Analyze trade-offs in interconnected wireless embedded device networks. Select Appropriate Protocols for IoT Solutions

CO5: Design a simple IoT system comprising sensors by analyzing the requirements of IoT Application

CO6: Identify the Application of IoT in automation of Commercial and Real World examples

Course Contents

Unit I	Fundamentals of Computer Organization & Digital Electronics	(09 Hours)

Basic Organization of Computers, Classification Micro, Mini, Mainframe and Super Computer. System Bus and Interconnection, PCI, Computer Function, I-Cycle, Interrupt and Class of Interrupts.
Number systems, Decimal Number system, Binary number system, Octal & Hexadecimal number system, 1's & 2's complement, Binary Fixed Point Representation.

#Exemplar/Case Studies	Various sensors and its internal operation
Mapping of Course Outcomes for Unit I	CO1

Unit II	Communication Interface	(06 Hours)

Basic Peripherals & their interfacing with 8086/8088, Semiconductor Memory Interfacing-Dynamic RAM Interfacing-Interfacing I/O ports-PIO-8255, Modes of operation-interfacing Analog-Digital Data converter-stepper motor interfacing.

#Exemplar/Case Studies	Arduino Uno 3
Mapping of Course Outcomes for Unit II	CO2

Unit III	Introduction & IOT Technologies behind smart and intelligent devices	(09 Hours)

IoT Concepts, Introduction to IOT Communications, Telemetry vs IOT, Applications of IOT Communications, People, Processes and Devices.
Automation, asset management, telemetry, transportation, telematics. Telemetry and Telemetric; Report

location, logistics, tracking and remote assistance; Next generation kiosks, self-service technology; Cellular IOT connectivity services.

#Exemplar/Case Studies	Big Data, Cloud Computing
Mapping of Course Outcomes for Unit III	CO3

Unit IV	IoT Systems, Network and Protocols	(07 Hours)

Study of RF Wireless Sensors; Wireless networks; Wireless Sensor Networking (WSN); Cellular Machine-to-Machine (M2M) application networks; Computer Connected to Internet; Network Devices; Device configuration and management; Exchange information in real time without human intervention; IoT Protocols.

#Exemplar/Case Studies	RFID, Industry 4.0- IOT
Mapping of Course Outcomes for Unit IV	CO4

Unit V	IOT Design and System Engineering	(06 Hours)

Discuss IOT Requirements; Hardware & Software; Study of IOT Sensors; Tagging and Tracking; Embedded Products; IOT Design; SIM Card Technology; IOT Connectivity and Management; IOT Security & IOT Communication.

#Exemplar/Case Studies	ACOEM Eagle – EnOcean Push Button – NEST Sensor – Ninja Blocks -Focus on Wearable Electronics
Mapping of Course Outcomes for Unit V	CO5

Unit VI	IOT Applications	(07 Hours)

IOT Verticals; IOT Hosted Services; IOT Application development, IOT Connectivity; IOT Software providers; Review of various IoT application domains including agriculture, healthcare, manufacturing, device management, and vehicle to vehicle communication and wearable computing devices.

#Exemplar/Case Studies	Rural Development using IOT
Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:
1. ArshdeepBahga, Vijay Madisetti, "Internet of Things: A hands-on approach", Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515.
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things: Key applications and Protocols", Wiley, 2012, ISBN:978-1-119-99435-0

Reference Books:
1. David Hanes, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, ISBN-13: 978-1-58714-456-1, ISBN-10: 1-58714-456-5, 2017
2. Olivier Hersent, Omar Elloumi and David Boswarthick, "The Internet of Things: Applications to the Smart Grid and Building Automation", Wiley, 2012, 9781119958345 3.
3. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", Wiley, 2014, ISBN: 978-1-118-43063-7

e-Books: Internet of Things and Access Control: Sensing, Monitoring and Controlling Access in IoT-Enabled Healthcare Systems (Smart Sensors, Measurement and Instrumentation Book 37), 1st Edition, Kindle Edition

MOOC Courses: Introduction to IoT (NPTEL) by Prof. Sudip Mishra, IITKGP.

@The CO-PO mapping table

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	▮
CO2	1	2	-	-	-	-	-	-	-	-	-	-
CO3	1	-	-	-	-	-	-	-	-	-	-	2
CO4	1	2	-	2	-	-	-	-	-	-	-	▮
CO5	2	2	-	-	-	-	-	-	-	-	-	-
CO6	1	1	-	-	-	-	-	-	-	-	-	-

Home

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
210252: Data Structures and Algorithms

Teaching Scheme:	Credit	Examination Scheme:
Lecture: 03 Hours/Week	**03**	**Mid_Semester(TH): 30 Marks** **End_Semester(TH): 70 Marks**

Prerequisite Courses:	110005: Programming and Problem Solving 210242: Fundamentals of Data Structures
Companion Course:	217532: Data Structures and Algorithms Laboratory

Course Objectives:

The course is intended to provide the foundations of the practical implementation and usage of Data Structures and Algorithms to ensure that the learner evolves into a competent programmer capable of designing and analyzing implementations of data structures and algorithms for different kinds of problems.

- To develop a logic for graphical modeling of the real life problems.
- To suggest appropriate data structure and algorithm for graphical solutions of the problems.
- To understand advanced data structures to solve complex problems in various domains.
- To operate on the various structured data
- To build the logic to use appropriate data structure in logical and computational solutions.
- To understand various algorithmic strategies to approach the problem solution.

Course Outcomes:

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

CO1: Identify and articulate the complexity goals and benefits of a good hashing scheme for real-world applications.

CO2: Apply non-linear data structures for solving problems of various domain.

CO3: Design and specify the operations of a nonlinear-based abstract data type and implement them in a high-level programming language.

CO4: Analyze the algorithmic solutions for resource requirements and optimization

CO5: Use efficient indexing methods and multiway search techniques to store and maintain data.

CO6: Use appropriate modern tools to understand and analyze the functionalities confined to the secondary storage.

Course Contents

Unit I	Hashing	(07 Hours)

Hash Table- Concepts-hash table, hash function, basic operations, bucket, collision, probe, synonym, overflow, open hashing, closed hashing, perfect hash function, load density, full table, load factor, rehashing, issues in hashing, hash functions- properties of good hash function, division, multiplication, extraction, mid-square, folding and universal, Collision resolution strategies- open addressing and chaining, Hash table overflow- open addressing and chaining, extendible hashing, closed addressing and separate chaining.

Skip List- representation, searching and operations- insertion, removal

#Exemplar/Case Studies	Book Call Number and Dictionary
Mapping of Course Outcomes for Unit I	CO1, CO4

Unit II	Trees	(08 Hours)

Tree- basic terminology, General tree and its representation, representation using sequential and linked organization, Binary tree- properties, converting tree to binary tree, binary tree traversals(recursive and non-recursive)- inorder, preorder, post order, depth first and breadth first, Operations on binary tree. Huffman Tree (Concept and Use), Binary Search Tree (BST), BST operations, Threaded binary search tree- concepts, threading, insertion and deletion of nodes in in-order threaded binary search tree, in order traversal of in-order threaded binary search tree.

#Exemplar/Case Studies	Use of binary tree in expression tree-evaluation and Huffman's coding
Mapping of Course Outcomes for Unit II	CO2, CO3,CO4

Unit III	**Graphs**	**(07 Hours)**

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

#Exemplar/Case Studies	Data structure used in Webgraph and Google map
Mapping of Course Outcomes for Unit III	CO2,CO3, CO4

Unit IV	**Search Trees**	**(08 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.

#Exemplar/Case Studies	Keyword search in a document using OBST
Mapping of Course Outcomes for Unit IV	CO2, CO3, CO5

Unit V	**Indexing and Multiway Trees**	**(07 Hours)**

Indexing and Multiway Trees- Indexing, indexing techniques-primary, secondary, dense, sparse, Multiway search trees, B-Tree- insertion, deletion, B+Tree - insertion, deletion, use of B+ tree in Indexing, Trie Tree.

#Exemplar/Case Studies	Heap as a Priority Queue
Mapping of Course Outcomes for Unit V	CO2, CO3, CO5

Unit VI	**File Organization**	**(07 Hours)**

Files: concept, need, primitive operations. **Sequential file organization-** concept and primitive operations, **Direct Access File-** Concepts and Primitive operations, **Indexed sequential file organization-**concept, types of indices, structure of index sequential file, **Linked Organization-**multi list files, coral rings, inverted files and cellular partitions.

#Exemplar/Case Studies	**External Sort-** Consequential processing and merging two lists, multiway merging- a k way merge algorithm
Mapping of Course Outcomes for Unit VI	CO4, CO6

Learning Resources

Text Books:
1. Horowitz, Sahani, Dinesh Mehata, "Fundamentals of Data Structures in C++", Galgotia Publisher, ISBN: 8175152788, 9788175152786.
2. M Folk, B Zoellick, G. Riccardi, "File Structures", Pearson Education", ISBN:81-7758-37-5
3. Peter Brass, "Advanced Data Structures", Cambridge University Press, ISBN: 978-1-107-43982-5

Reference Books:

1. A. Aho, J. Hopcroft, J. Ulman, "Data Structures and Algorithms", Pearson Education, 1998, ISBN-0-201-43578-0.
2. Michael J Folk, "File Structures an Object Oriented Approach with C++", Pearson Education, ISBN: 81-7758-373-5.
3. Sartaj Sahani, "Data Structures, Algorithms and Applications in C++", Second Edition, University Press, ISBN: 81-7371522 X.
4. G A V Pai, "Data Structures and Algorithms", McGraw-Hill Companies, ISBN - 9780070667266.
5. Goodrich, Tamassia, Goldwasser, "Data Structures and Algorithms in Java", Wiley Publication, ISBN: 9788126551903

e-Books:

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

MOOC/ Video Lectures available at:

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

@The CO-PO Mapping Matrix

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	-	-	-	-	-	-	-
CO2	1	2	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	-	2	-	1	-	-	-	-	-	-	-	-
CO5	1	-	1	1	-	-	-	-	-	-	-	-
CO6	2	1	1	1	-	-	-	-	-	-	-	-

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) 210253: Software Engineering		
Teaching Scheme	**Credit Scheme**	**Examination Scheme and Marks**
Lecture: 03 Hours/Week	**03**	**Mid_Semester(TH): 30 Marks** **End_Semester(TH): 70 Marks**

Prerequisite Courses :　　110005: Programming and Problem Solving

Companion Course :　　　---

Course Objectives:

The main objective of this course is to introduce the students to software engineering- the fundaments of software engineering principles and practices, including project management, configurations management, requirements definition, system analysis, design, testing, and deployment with hands-on experience in a group software development project.

- To learn and understand the principles of Software Engineering.
- To be acquainted with methods of capturing, specifying, visualizing and analyzing software requirements.
- To apply design and testing principles to software project development.
- To understand project management through life cycle of the project.

Course Outcomes:

On completion of the course, learner will be able to-

CO1: Analyze software requirements and formulate design solution for a software.

CO2: Design applicable solutions in one or more application domains using software engineering approaches that integrate ethical, social, legal and economic concerns.

CO3: Apply new software models, techniques and technologies to bring out innovative and novelistic solutions for the growth of the society in all aspects and evolving into their continuous professional development.

CO4: Model and design User interface and component-level.

CO5: Identify and handle risk management and software configuration management.

CO6: Utilize knowledge of software testing approaches, approaches to verification and validation.

CO7: Construct software of high quality – software that is reliable, and that is reasonably easy to understand, modify and maintain efficient, reliable, robust and cost-effective software solutions.

Course Contents		
Unit I	**Introduction to Software Engineering and Software Process Models**	**(06Hours)**

Software Engineering Fundamentals: Introduction to software engineering, The Nature of Software, Defining Software, Software Engineering Practice. **Software Process:** A Generic Process Model, defining a Framework Activity, Identifying a Task Set, Process Patterns, Process Assessment and Improvement, Prescriptive Process Models, The Waterfall Model, Incremental Process Models, Evolutionary Process Models, Concurrent Models, A Final Word on Evolutionary Processes. Unified Process, Agile software development: Agile methods, plan driven and agile development.

#Exemplar/Case Studies	Agile Tools- JIRA
***Mapping of Course Outcomes for Unit I**	CO1, CO3, CO7

Unit II	**Software Requirements Engineering and Analysis**	**(07 Hours)**

Home
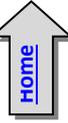
Modeling: Requirements Engineering, Establishing the Groundwork, Identifying Stakeholders, Recognizing Multiple Viewpoints, working toward Collaboration, Asking the First Questions, Eliciting Requirements, Collaborative Requirements Gathering, Usage Scenarios, Elicitation Work Products, Developing Use Cases, Building the Requirements Model, Elements of the Requirements Model, Negotiating Requirements, Validating Requirements.
Suggested Free Open Source tools: StarUML, Modelio, SmartDraw.

#Exemplar/Case Studies	Write SRS in IEEE format for selected Project Statement/ case study Study SRS of Online Voting system (http://dos.iitm.ac.in/OOSD_Material/CaseStudies/CaseStudy2/eVote-srs.pdf), Library management System, Develop use case model for any software applications.
*Mapping of Course Outcomes for Unit II	CO1, CO3, CO7

Unit III	Estimation and Scheduling	(07 Hours)

Estimation for Software Projects: The Project Planning Process, Defining Software Scope and Checking Feasibility, Resources management, Reusable Software Resources, Environmental Resources, Software Project Estimation, Decomposition Techniques, Software Sizing, Problem-Based Estimation, LOC-Based Estimation, FP-Based Estimation, Object Point (OP)-based estimation, Process-Based Estimation, Process-Based Estimation, Estimation with Use Cases, Use-Case–Based Estimation, Reconciling Estimates, Empirical Estimation Models, The Structure of Estimation Models, The COCOMO II Mode, Preparing Requirement Traceability Matrix
Project Scheduling: Project Scheduling, Defining a Task for the Software Project, Scheduling.
Suggested Free Open Source Tools: Gantt Project, Agantty, Project Libre.

#Exemplar/Case Studies	Write SRS in IEEE format for selected Project Statement/ case study, Study SRS of Online Voting system, Library management System (http://dos.iitm.ac.in/OOSD_Material/CaseStudies/CaseStudy2/eVote-srs.pdf),
*Mapping of Course Outcomes for Unit III	CO1, CO3, CO7

Unit IV	Design Engineering	(07 Hours)

Design Concepts: Design within the Context of Software Engineering, The Design Process, Software Quality Guidelines and Attributes, Design Concepts - Abstraction, Architecture, design Patterns, Separation of Concerns, Modularity, Information Hiding, Functional Independence, Refinement, Aspects, Refactoring, Object-Oriented Design Concept, Design Classes, The Design Model , Data Design Elements, Architectural Design Elements, Interface Design Elements, Component-Level Design Elements, Component Level Design for Web Apps, Content Design at the Component Level, Functional Design at the Component Level, Deployment-Level Design Elements.
Architectural Design: Software Architecture, What is Architecture, Why is Architecture Important, Architectural Styles, A brief Taxonomy of Architectural Styles.
 Suggested Free Open Source Tool: Smart Draw

#Exemplar/Case Studies	Study design of Biometric Authentication software
*Mapping of Course Outcomes for Unit IV	CO1,CO2 CO3, CO7

Unit V	Risks and Configuration Management	(07 Hours)

Risk Management: Software Risks, Risk Identification, Risk Projection, Risk Refinement, Risk Mitigation, Monitoring, and Management, The RMMM Plan.
Software Configuration Management: Software Configuration Management, The SCM Repository The SCM Process, Configuration Management for any suitable software system.
Suggested Free Open Source Tools: CF Engine Configuration Tool, Puppet Configuration Tool.

#Exemplar/Case Studies	Risk management in Food delivery software
*Mapping of Course Outcomes for Unit V	CO1,CO2 CO3, CO7

Unit VI	Software Testing	(07 Hours)

A Strategic Approach to Software Testing, Verification and Validation, Organizing for Software Testing, Software Testing Strategy—The Big Picture, Criteria for Completion of Testing, Strategic Issues, Test Strategies for Conventional Software, Unit Testing, Integration Testing, Test Strategies for Object-Oriented Software, Unit Testing in the OO Context, Integration Testing in the OO Context, Test Strategies forWebApps, Validation Testing, Validation-Test Criteria, Configuration Review.

Suggested Free Open Source Tools: Selenium, JUnit.

#Exemplar/Case Studies	Selemium Testing with any online application
*Mapping of Course Outcomes for Unit VI	CO1,CO2 CO3, CO6

Learning Resources

Text Books:

1. Roger Pressman, "Software Engineering: A Practitioner's Approach", McGraw Hill, ISBN 0–07–337597–7
2. Ian Sommerville, "Software Engineering", Addison and Wesley, ISBN 0-13-703515-2

Reference Books:

1. Carlo Ghezzi, "Fundamentals of Software Engineering", PHI, ISBN-10: 0133056996
2. Rajib Mall, "Fundamentals of Software Engineering", PHI, ISBN-13: 978-8120348981
3. Pankaj Jalote, "An Integrated Approach to Software Engineering", Springer, ISBN 13: 9788173192715.
4. S K Chang, "Handbook of Software Engineering and Knowledge Engineering", World Scientific, Vol I, II, ISBN: 978-981-02-4973-1
5. Tom Halt, "Handbook of Software Engineering", Clanye International, ISBN- 10: 1632402939

e-books:

- https://ebookpdf.com/roger-s-pressman-software-engineering

MOOC/ Video Lectures available at:

- https://swayam.gov.in/nd1_noc19_cs69/preview
- https://swayam.gov.in/nd2_cec20_cs07/preview

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	2	-	-	-	-	-	-	-	-	-	-
CO2	1	-	-	-	-	2	2	2	-	-	-	-
CO3	-	-	2	-	-	2	-	-	-	-	-	-
CO4	-	2	2	-	-	-	-	-	-	-	-	-
CO5	-	2	2	-	-	-	-	-	-	-	-	-
CO6	-	2	2	-	-	-	-	-	-	-	-	-
CO7	1	-	1	1	-	-	-	-	-	-	-	-

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) 217530: Management Information Systems		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Lecture: 03 Hours/Week	**03**	**Mid_Semester (TH): 30 Marks** **End_Semester(TH): 70 Marks**

Prerequisite Courses, if any: ---

Companion Course, if any: ---

Course Objectives:
- To understand concepts of Management Information System and Business intelligence for MIS.
- To recognize the need of an information system in today's global business with tools and technologies.
- To identify IT infrastructure components and to study security in the Information System.
- To understand the importance of project management and the international information system.
- To understand the concepts of decision support systems for business applications.
- To understand artificial intelligence and data science for Management Information System

Course Outcomes:
On completion of the course, learner will be able to–
CO1 : Explain the concepts of Management Information System and Business intelligence for MIS.
CO2 : Illustrate the need of information systems in global business and ethical issues.
CO3 : List the IT infrastructure components and **explain** security in the Information System.
CO4 : Demonstrate the importance of project management and **extend** its use in the international information system.
CO5 : Illustrate the concepts of decision support systems for business applications.
CO6 : Relate artificial intelligence and data science for Management Information System.

Course Contents

Unit I	An Overview of Management Information System	(07 Hours)

Management information system: Concept, MIS: Definition, Role of MIS, Impact of MIS, MIS & the User, Management as a Control System: The functions of Management, Managerial Roles, The Levels of Management[R3]. MIS: A Support to the Management, Management effectiveness and MIS, Organization as a System. Decision Making, Information, Knowledge and Business intelligence, Business intelligence for MIS.

#Exemplar/Case Studies	Case study on General Life insurance company
Mapping of Course Outcomes for Unit I	CO1

Unit II	Organization, Management and Network Enterprise	(07Hours)

Information systems in today's global business: The Role of information system, Perspective's on Information System. Global E-business and collaboration: Business Processes, Types of Information Systems. System for Collaboration and Team Work: Tools and technologies for collaboration and team work, E-mail and Instant Messaging, Social Networking, Virtual worlds, Internet based Collaboration Environments. Information system organization and strategy, Ethical and social issues in information system.

| **#Exemplar/Case Studies** | Collaboration & Innovation at Procter and Gamble(P&G) |
| **Mapping of Course Outcomes for Unit II** | CO2 |

Unit III	**Information Technology Infrastructure**	**(07 Hours)**

IT infrastructure and Emerging Technologies: IT infrastructure and its components, Hardware and software platform trends, Management issues. Foundation of Business intelligence: Databases and information management. Telecommunication, The Internet and Wireless technology, Securing information systems: system vulnerability, Business value of security and control.

| **#Exemplar/Case Studies** | IPL Teams strike Gold with information Technology |
| **Mapping of Course Outcomes for Unit III** | CO3 |

Unit IV	**Key System Applications for Digital Age**	**(07 Hours)**

Achieving operational Excellence and customer intimacy : Enterprise Applications, **E-Commerce**: Digital Markets and Digital Goods , Managing knowledge, **Enhancing Decision Making**, Building information Systems, Managing project : The importance of project Management, the business value of information systems, Managing project risk, Managing Global Systems: The growth of international information systems, organizing international information systems, Technology issues and opportunities for global value chain.

| **#Exemplar/Case Studies** | CoCa-Cola: "Opening Happiness" with a New Project Management System |
| **Mapping of Course Outcomes for Unit IV** | CO4 |

Unit V	**Business Applications**	**(07 Hours)**

Introduction to e-business systems: Functional Business systems, cross functional Enterprise systems. Customer Relationship Management: The Business focus, Enterprise Resource Planning: The business backbone, Supply chain Management: Business Network. Electronic Commerce Systems: Fundamentals, **e-commerce** applications and issues. **Decision support systems:** Decision support in Business, DSS Components, Decision Supports Trends, OLTP, Data Mining for Decision Support, Knowledge Management System.

| **#Exemplar/Case Studies** | Amazon Vs Walmart: Which giant will dominate E-commerce? |
| **Mapping of Course Outcomes for Unit V** | CO5 |

Unit VI	**Artificial Intelligence & Data Science for MIS**	**(07 Hours)**

Business and AI, An overview of Artificial Intelligence, Neural Network, Fuzzy Logic System, Genetic Algorithms, Virtual Reality, Intelligent Agents, Expert Systems: Components, Applications, Developing Expert Systems, The Value of Expert Systems: Benefits & Limitations.

MIS in Data Science: Transition into data science for a Business Intelligence (BI)/MIS professional: performing detective analytics and generate insights from reports, statistics to support your insights about reports, present your findings to the right group, explore an open-source tool to generate reports OR to perform detective analysis, the model building / predictive modeling steps, Methods to evaluate

your model's performance.	
#Exemplar/Case Studies	Cisco Systems, Netflix.
Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1.Waman S. Javadekar," Management Information System: A Global Digital Enterprise Perspective", McGraw Hill Education Pvt. Ltd. 5th Edition, ISBN – 13:978-1-25-902669-0.

2. James A. O'Brien, George M Marakas, "Management Information Systems", The McGraw-Hill Companies, 7th Edition, ISBN-0-07-062-003-2.

Reference Books:

1.Kenneth C. Laudon, Jane P. Laudon, "Management information Systems: Managing the Digital Firm", Perason, 12th Edition, ISBN-978-81-317-8746-5.

2.James A. O'Brien," Management Information Systems: Managing information Technology in the Business Enterprise", Tata McGraw Hill Edition, 6th Edition, ISBN- 0-07-058739-6.

3.Robert Schultheis, Marry sumner, "Management information system: The Manager's View", Tata McGraw Hill Edition, 4th Edition, ISBN-0-07-463879-3.

4. Gordon B.Davis, Margrethe H. Olson, "Management Information Systems : Conceptual Foundations, Structure and Development", Tata McGraw Hill Edition, 2nd Editon,ISBN-13:978-0-07-040267-6

e-Books:

1.   https://repository.dinus.ac.id/docs/ajar/Kenneth_C.Laudon,Jane_P_.Laudon_-_Management_Information_Sysrem_13th_Edition_.pdf

2.   https://www.sohailuniversity.edu.pk/wp-content/uploads/2018/12/Management-Information-Systems-OBrien.pdf

3.   https://sctevtservices.nic.in/docs/website/pdf/140304.pdf

MOOC Courses:

https://nptel.ac.in/courses/110/105/110105148/

https://nptel.ac.in/courses/122/105/122105022/

https://onlinecourses.swayam2.ac.in/cec21_ge05/preview

@The CO-PO mapping table

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	1	-	-	-	-	-	-	-	-
CO2	1	1	1	-	-	-	-	1	1	-	-	-
CO3	2	1	1	-	-	-	-	-	-	-	-	-
CO4	2	1	1	1	-	-	-	-	-	-	1	-
CO5	2	2	2	1	1	-	-	-	-	-	-	-
CO6	2	2	2	1	1	-	-	-	-	-	-	-

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) 217531: Internet of Things Laboratory		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 04 Hours/Week	**02**	**Term Work (TW): 50 Marks** **Practical(PR): 25 Marks**

Prerequisite Courses: Programming and Problem Solving (110005),
                            Basic Electronics Engineering (104010)

Companion Course: Internet of Things (217529)

Course Objectives:
- Hardware platforms and operating systems commonly used in IoT systems.
- Help the students in providing a good learning environment and also work with real time problems faced in day to day life.

Course Outcomes:

On completion of the course, learner will be able to–
  CO1: Understand IOT Application Development using Raspberry Pi/ Beagle board/ Arduino board
  CO2: Develop and modify the code for various sensor based applications using wireless sensor modules and working with a variety of modules like environmental modules.
  CO3: Make use of Cloud platform to upload and analyse any sensor data

Guidelines:

Lab Assignments: Following is list of suggested laboratory assignments for reference. Laboratory Instructors may design a suitable set of assignments for their respective course at their level. Beyond curriculum assignments and mini-project may be included as a part of laboratory work. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. The Inclusion of a few optional assignments that are intricate and/or beyond the scope of curriculum will surely be the value addition for the students and it will satisfy the intellectuals within the group of the learners and will add to the perspective of the learners. For each laboratory assignment, it is essential for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorial may be as per guidelines of authority.

· **Term Work**: Term work is continuous assessment that evaluates a student's progress throughout the semester. Term work assessment criteria specify the standards that must be met and the evidence that will be gathered to demonstrate the achievement of course outcomes. Categorical assessment criteria for the term work should establish unambiguous standards of achievement for each course outcome. They should describe what the learner is expected to perform in the laboratories or on the fields to show that the course outcomes have been achieved. It is recommended to conduct an internal monthly practical examination as part of continuous assessment.

· **Assessment:** Students' work will be evaluated typically based on the criteria like attentiveness, proficiency in execution of the task, regularity, punctuality, use of referencing, accuracy of language, use of supporting evidence in drawing conclusions, quality of critical thinking and similar performance measuring criteria.

·**Laboratory Journal:** Program codes with sample output of all performed assignments are to be submitted as softcopy. Use of DVD or similar media containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory. 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 journals may be avoided. Submission of journal/ term work in the form of softcopy is desirable and appreciated.

Suggested List of Laboratory Experiments/Assignments

Student should perform all assignments from Group A, at least 8 experiments with all experiments from group B and any 1 assignment from Group C. (Use suitable programming language/Tool for implementation)

List of Assignments

Group A

1. Study of Raspberry-Pi/ Beagle board/ Arduino and other microcontroller (History & Elevation)

2. Study of different operating systems for Raspberry-Pi /Beagle board/Arduino. Understanding the process of OS installation

3. Study of different GATES (AND, OR, XOR), Sensors and basic binary operations.

4. Study of Connectivity and configuration of Raspberry-Pi /Beagle board/Arduino circuit with basic peripherals like LEDS. Understanding GPIO and its use in the program.

Group B

5. Write a program using Arduino to control LED (One or more ON/OFF). Or Blinking

6. Create a program that illuminates the green LED if the counter is less than 100, illuminates the yellow LED if the counter is between 101 and 200 and illuminates the red LED if the counter is greater than 200

7. Create a program so that when the user enters 'b' the green light blinks, 'g' the green light is illuminated 'y' the yellow light is illuminated and 'r' the red light is illuminated

8. Write a program that asks the user for a number and outputs the number squared that is entered

9. Write a program to control the color of the LED by turning 3 different potentiometers. One will be read for the value of Red, one for the value of Green, and one for the value of Blue

10. Write a program read the temperature sensor and send the values to the serial monitor on the computer

11. Write a program so it displays the temperature in Fahrenheit as well as the maximum and minimum temperatures it has seen

12. Write a program to show the temperature and shows a graph of the recent measurements

13. Write a program using piezo element and use it to play a tune after someone knocks

14. Understanding the connectivity of Raspberry-Pi /Beagle board circuit / Arduino with IR sensor. Write an application to detect obstacle and notify user using LEDs

Group C

15. Study of ThingSpeak – an API and Web Service for the Internet of Things (Mini Project: Same can be done parallel with PBL)

16. Write an application to control the operation of hardware simulated traffic signals. (Mini Project: Same can be done parallel with PBL)

17. Develop a Real time application like smart home with following requirements: When the user enters into the house the required appliances like fan, light should be switched ON. Appliances should also get controlled remotely by a suitable web interface. The objective of this application is that students should construct complete Smart applications in groups. (Mini Project: Same can be done parallel with PBL)

18. Write an application for stopwatch or countdown timer. (Mini Project: Same can be done parallel with PBL)

Learning Resources

Text Books:

1. Alan G. Smith, " Introduction to Arduino: A piece of cake"
2. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012. ISBN : 9781439892992

Reference Books:

1. Olivier Hersent, Omar Elloumi and David Boswarthick, "The Internet of Things: Applications to the Smart Grid and Building Automation", Wiley, 2012, 9781119958345 3.
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things: Key applications and Protocols", Wiley, 2012, ISBN:978-1-119-99435-0

@The CO-PO mapping table

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	--	--	--	--	--	--	--	--	--
CO2	--	2	3	--	--	--	--	--	--	--	--	--
CO3	--	--	3	2	--	--	--	--	--	--	--	3
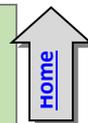
Savitribai Phule Pune University
Second Year of Computer Engineering (2019 Course)
217532: Data Structures and Algorithms Laboratory

Teaching Scheme Practical: **04 Hours/Week**	Credit Scheme **02**	Examination Scheme and Marks Term Work: **25 Marks** Practical: **25 Marks**

Prerequisite Courses:	110005: Programming and Problem Solving, 217522: Data Structures Laboratory
Companion Course :	210252: Data Structures and Algorithms

Course Objectives:

- To **understand** practical implementation and usage of non linear data structures for solving problems of different domain.
- To strengthen the ability to identify and **apply** the suitable data structure for the given real world problems.
- To **analyze** advanced data structures including hash table, dictionary, trees, graphs, sorting algorithms and file organization.

Course Outcomes:

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

CO1: Understand the ADT/libraries, hash tables and dictionary to design algorithms for a specific problem.

CO2: Choose most appropriate data structures and **apply** algorithms for graphical solutions of the problems.

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

CO4: Apply and **analyze** algorithm design techniques for indexing, sorting, multi-way searching, file organization and compression.

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

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a hands-on resource and reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface), curriculum of course, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and 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. Use of DVD containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

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 need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute 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, instructor may assign one real life application in the form of a mini-project based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

Set of suggested assignment list is provided in groups- A, B, C, D, E, F and G. Each student must perform at least 12 assignments(at least 02 from group A, 03 from group B, 02 from group C, 2 from group D, 01 from group E, 02 from group F.)

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

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

Guidelines for Practical Examination

Both internal and external examiners should jointly set problem statements. During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement. The supplementary and relevant questions may be asked at the time of evaluation to test the student's for advanced learning, understanding of the fundamentals, effective and efficient implementation. Consequently encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. Therefore adhering to these principles will consummate our team efforts to the promising start of the student's academics.

Virtual Laboratory:

- http://cse01-iiith.vlabs.ac.in/Courses%20Aligned.html?domain=Computer%20Science

Suggested List of Laboratory Experiments/Assignments

Sr. No	Group A
1	Consider telephone book database of N clients. Make use of a hash table implementation to quickly look up client's telephone number. Make use of two collision handling techniques and compare them using number of comparisons required to find a set of telephone numbers
2	Implement all the functions of a dictionary (ADT) using hashing and handle collisions using chaining with / without replacement. Data: Set of (key, value) pairs, Keys are mapped to values, Keys must be comparable, Keys must be unique. Standard Operations: Insert(key, value), Find(key), Delete(key)
3	For given set of elements create skip list. Find the element in the set that is closest to some given value. (note: Decide the level of element in the list Randomly with some upper limit)
4	To create ADT that implement the "set" concept. a. Add (new Element) -Place a value into the set , b. Remove (element) Remove the value c. Contains (element) Return true if element is in collection, d. Size () Return number of values in collection Iterator () Return an iterator used to loop over collection, e. Intersection of two sets , f. Union of two sets, g. Difference between two sets, h. Subset

	Group B
5	A book consists of chapters, chapters consist of sections and sections consist of subsections. Construct a tree and print the nodes. Find the time and space requirements of your method.
6	Beginning with an empty binary search tree, Construct binary search tree by inserting the values in the order given. After constructing a binary tree - i. Insert new node, ii. Find number of nodes in longest path from root, iii. Minimum data value found in the tree, iv. Change a tree so that the roles of the left and right pointers are swapped at every node, v. Search a value
7	Construct an expression tree from the given prefix expression eg. +--a*bc/def and traverse it using post order traversal (non recursive) and then delete the entire tree.
8	Read for the formulas in propositional calculus. Write a function that reads such a formula and creates its binary tree representation. What is the complexity of your function?
9	Convert given binary tree into threaded binary tree. Analyze time and space complexity of the algorithm.

10	Consider threading a binary tree using preorder threads rather than inorder threads. Design an algorithm for traversal without using stack and analyze its complexity. _
11	A Dictionary stores keywords and its meanings. Provide facility for adding new keywords, deleting keywords, updating values of any entry. Provide facility to display whole data sorted in ascending/ Descending order. Also find how many maximum comparisons may require for finding any keyword. Use Binary Search Tree for implementation.
12	Implement a file compression algorithm that uses binary tree. Your program should allow the user to compress and decompress messages containing alphabets using the standard Huffman algorithm for encoding and decoding.
	Group C
13	Represent a given graph using adjacency matrix/list to perform DFS and using adjacency list to perform BFS. Use the map of the area around the college as the graph. Identify the prominent land marks as nodes and perform DFS and BFS on that.
14	There are flight paths between cities. If there is a flight between city A and city B then there is an edge between the cities. The cost of the edge can be the time that flight take to reach city B from A, or the amount of fuel used for the journey. Represent this as a graph. The node can be represented by airport name or name of the city. Use adjacency list representation of the graph or use adjacency matrix representation of the graph. Check whether the graph is connected or not. Justify the storage representation used.
15	You have a business with several offices; you want to lease phone lines to connect them up with each other; and the phone company charges different amounts of money to connect different pairs of cities. You want a set of lines that connects all your offices with a minimum total cost. Solve the problem by suggesting appropriate data structures.
16	Tour operator organizes guided bus trips across the Maharashtra. Tourists may have different preferences. Tour operator offers a choice from many different routes. Every day the bus moves from starting city S to another city F as chosen by client. On this way, the tourists can see the sights alongside the route travelled from S to F. Client may have preference to choose route. There is a restriction on the routes that the tourists may choose from, the bus has to take a short route from S to F or a route having one distance unit longer than the minimal distance. Two routes from S to F are considered different if there is at least one road from a city A to a city B which is part of one route, but not of the other route.
17	Consider the scheduling problem. n tasks to be scheduled on single processor. Let t1, ...,tn be durations required to execute on single processor is known. The tasks can be executed in any order but one task at a time. Design a greedy algorithm for this problem and find a schedule that minimizes the total time spent by all the tasks in the system. (The time spent by one is the sum of the waiting time of task and the time spent on its execution.)
	Group D
18	Given sequence k = k1 <k2 < … <kn of n sorted keys, with a search probability pi for each key ki . Build the Binary search tree that has the least search cost given the access probability for each key?
19	A Dictionary stores keywords and its meanings. Provide facility for adding new keywords, deleting keywords, updating values of any entry. Provide facility to display whole data sorted in ascending/ Descending order. Also find how many maximum comparisons may require for finding any keyword. Use Height balance tree and find the complexity for finding a keyword
	Group E
20	Consider a scenario for Hospital to cater services to different kinds of patients as Serious (top priority), b) non-serious (medium priority), c) General Checkup (Least priority). Implement the priority queue to cater services to the patients.
21	Implement the Heap/Shell sort algorithm implemented in Java demonstrating heap/shell data structure with modularity of programming language

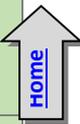|	
22	Read the marks obtained by students of second year in an online examination of particular subject. Find out maximum and minimum marks obtained in that subject. Use heap data structure. Analyze the algorithm.
	Group F
23	Department maintains a student information. The file contains roll number, name, division and address. Allow user to add, delete information of student. Display information of particular employee. If record of student does not exist an appropriate message is displayed. If it is, then the system displays the student details. Use sequential file to main the data.
24	Company maintains employee information as employee ID, name, designation and salary. Allow user to add, delete information of employee. Display information of particular employee. If employee does not exist an appropriate message is displayed. If it is, then the system displays the employee details. Use index sequential file to maintain the data.
25	Implementation of a direct access file -Insertion and deletion of a record from a direct access file
26	Assume we have two input and two output tapes to perform the sorting. The internal memory can hold and sort m records at a time. Write a program in java for external sorting. Find out time complexity.
	Mini-Projects/ Case Study
27	Design a mini project using C++ which will use the different data structure with or without C++ library and show the use of specific data structure on the efficiency (performance) of the code.
28	Design a mini project to implement Snake and Ladders Game using Python.
29	Design a mini project to implement a Smart text editor.
30	Design a mini project for automated Term work assessment of student based on parameters like daily attendance, Unit Test / Prelim performance, Students achievements if any, Mock Practical.
	@The CO-PO Mapping Matrix

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	-	-	-	-	-	-	-	-	-
CO2	-	2	2	-	-	-	-	-	-	-	-	-
CO3	-	2	2	1	-	-	-	-	-	-	-	-
CO4	1	2	1	1	-	-	-	-	-	-	-	-
CO5	1	1	2	2	-	-	-	-	-	-	-	-

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) 217533: Project Based Learning II		
Teaching Scheme **Practical: 04 Hours/Week**	**Credit Scheme** **02**	**Examination Scheme and Marks** **Term Work: 50 Marks**

Course Objectives:

- To develop critical thinking and problem solving ability by exploring and proposing solutions to realistic/social problem.
- To Evaluate alternative approaches, and justify the use of selected tools and methods.
- To emphasizes learning activities that are long-term, inter-disciplinary and student-centric.
- To engages students in rich and authentic learning experiences.
- To provide every student the opportunity to get involved either individually or as a group so as to develop team skills and learn professionalism.
- To develop an ecosystem that promotes entrepreneurship and research culture among the students.

Course Outcomes:

CO1: Identify the real life problem from societal need point of view
CO2: Choose and compare alternative approaches to select most feasible one
CO3: Analyze and synthesize the identified problem from technological perspective
CO4: Design the reliable and scalable solution to meet challenges
CO5: Evaluate the solution based on the criteria specified
CO6: Inculcate long life learning attitude towards the societal problems

## Course Contents

Preamble:

Project-based learning is an instructional approach designed to give students the opportunity to develop knowledge and skills through engaging projects set around challenges and problems they may face in the real world. PBL, is more than just projects. With PBL students "investigate and respond to an authentic, engaging, and complex problem, or challenge" with deep and sustained attention. PBL is "learning by doing." The truth is, many in education are recognizing we live in a modern world sustained and advanced through the successful completion of projects. In short, If students are prepared for success in life, we need to prepare them for a project-based world. It is a style of active learning and inquiry-based learning. (Reference: Wikipedia). Project based learning will also redefine the role of teacher as mentor in learning process. Along with communicating knowledge to students, often in a lecture setting, the teacher will also to act as an initiator and facilitator in the collaborative process of knowledge transfer and development. The PBL model focuses the student on a big open-ended question, challenge, or problem to research and respond to and/or solve. It Brings what students should academically know, understand, and be able to do and requires students to present their problems, research process, methods, and results.[1]

Project based learning (PBL) requires regular mentoring by faculty throughout the semester for successful completion of the idea/project tasks selected by the students per batch. For the faculty involved in PBL , teaching workload of 4 Hrs/week/batch needs to be considered. The Batch should be divided into sub-groups of 4 to 5 students. Idea implementation /Real life problem/Complex assignments / activities / projects. under project based learning is to be carried throughout semester and Credit for PBL has to be awarded on the basis of internal continuous assessment and evaluation at the end of semester

Group Structure:

Working in supervisor/mentor monitored groups; the students plan, manage, and complete a task/project/activity which addresses the stated problem.

1. There should be team/group of 4-5 students
2. A supervisor/mentor teacher assigned to individual groups

Home
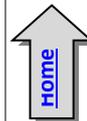
Selection of Project/Problem:

The problem-based project oriented model for learning is recommended. The model begins with the identifying of a problem, often growing out of a question or "wondering". This formulated problem then stands as the starting point for learning. Students design and analyze the problem/project within an articulated interdisciplinary or subject frame.

A problem can be theoretical, practical, social, technical, symbolic, cultural, and/or scientific and grows out of students' wondering within different disciplines and professional environments. A chosen problem has to be exemplary. The problem may involve an interdisciplinary approach in both the analysis and solving phases.

By exemplarity, a problem needs to refer back to a particular practical, scientific, social and/or technical domain. The problem should stand as one specific example or manifestation of more general learning outcomes related to knowledge and/or modes of inquiry.

There are no commonly shared criteria for what constitutes an acceptable project. Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content, and structure of the activity.

A few hands-on activities that may or may not be multidisciplinary.

Use of technology in meaningful ways to help them investigate, collaborate, analyse, synthesize, and present their learning.

Activities may include- Solving real life problem, investigation, /study and Writing reports of in depth study, field work.

Assessment:

The institution/head/mentor is committed to assessing and evaluating both student performance and program effectiveness.

Progress of PBL is monitored regularly on weekly basis. Weekly review of the work is necessary. During process of monitoring and continuous assessment and evaluation of the individual and the team performance is to be measured. PBL is monitored and continuous assessment is done by supervisor /mentor and authorities.

Students must maintain an institutional culture of authentic collaboration, self-motivation, peer-learning and personal responsibility. The institution/department should support students in this regard through guidance/orientation programs and the provision of appropriate resources and services. Supervisor/mentor and Students must actively participate in assessment and evaluation processes.

Group may demonstrate their knowledge and skills by developing a public product and/or report and/or presentation.

1. Individual assessment for each student (Understanding individual capacity, role and involvement in the project)

2. Group assessment (roles defined, distribution of work, intra-team communication and togetherness)

3. Documentation and presentation

Evaluation and Continuous Assessment:

It is recommended that all activities should to be recorded regularly, regular assessment of work need to be done and proper documents need to be maintained at college end by both students as well as mentor (PBL work book).

Continuous Assessment Sheet (CAS) is to be maintained by all mentors/department and institutes.

Recommended parameters for assessment/evaluation and weightage:

1. Idea Inception and Awareness /Consideration of -Environment/ Social /Ethics/ Safety measures/Legal aspects (10%)

2. Outcomes of PBL/ Problem Solving Skills/ Solution provided/ Final product (Individual assessment and team assessment) (40%)

3. Documentation (Gathering requirements, design and modelling, implementation/execution, use of technology and final report, other documents) (15%)

4. Demonstration (Presentation, User Interface, Usability) (20%)

5. Contest Participation/ publication (15%)

PBL workbook will serve the purpose and facilitate the job of students, mentor and project coordinator. It will reflect accountability, punctuality, technical writing ability and work flow of

the work undertaken.

Note :

- While planning for the assessment, choose a valid method based on your context. It should be able to understand by both the students as well as the faculty.
- The student group must follow the principles of Software Engineering (Scoping out the problem, the solution implementation and related documentation).
- Researching the problem and outlining various approaches is key here and should be emphasized by the tutor and the mentor.
- Aspects of design thinking (from the point of view of the person facing the problem) are very important. Students should not jump into the technology aspects first.
- The team can follow the principles of Agile Software Development. The weekly meetings could be used as a Scrum meeting.
- The tutor and mentor should actively help the students to scope the work and the approach. They must validate the technology choices.
- If the implementation code is well documented, the project can be continued by subsequent batch – which will help solve a bigger problem.

Text Books:

1. A new model of problem based learning. By Terry Barrett. All Ireland Society for higher education (AISHE). ISBN:978-0-9935254-6-9; 2017
2. Problem Based Learning. By Mahnazmoallem, woei hung and Nada Dabbagh, Wiley Publishers. 2019.
3. Stem Project based learning and integrated science, Technology, Engineering and mathematics approach. By Robert Capraro, Mary Margaret Capraro

Reference Books:

1. De Graaff E, Kolmos A., red.: Management of change: Implementation of problem-based and project-based learning in engineering. Rotterdam: Sense Publishers. 2007.
2. Gopalan," Project management core text book", 2 Indian Edition
3. James Shore and Shane Warden, " The Art of Agile Development"

Tutors Role in Project Based Learning

- The fundamentals of problem based learning, lies with the Tutors role.
- Tutors are not the source of solutions rather they act as the facilitator and mentor.
- The facilitator skills of the Tutors / Teacher are central to the success of PBL.

Change of Mindset

- Students are not used to the constructivist approach to learning, it is important that they are carefully told what to expect in PBL.
- Tutors need to explain the differences between PBL and traditional learning.
- Tutors need to explain the principals involved and role of the students in PBL learning.

Designing Problem

- Considering the prior knowledge of the students, their ability and creativity, problem statement should be designed.
- For 2nd year PBL students the tutor should place more emphasis on getting the students to perform higher-level tasks.
- It is important for tutors to design problems that are anchored in authentic contexts only
- Students should take ownership of the problem.
- Problems should not be over simplified or well defiled
- Learning should not be the sequencing of instructional events, but the application of principles for responding to the needs of the situation.
- The problems given to students in PBL should be realistic, complex, and should reflect, as much as possible, the actual problems that students would encounter in real life.

Basic function of the tutor

- A good understanding of the overall curriculum the students have to study, the principles of problems solving, critical thinking and meta-cognitive skills.

Grouping

- Study the background and profile of each student.

- Make sure that students of different backgrounds and experience are assigned in a group
- It is useful to group students of different abilities, gender, and nationalities together.
- Tutors must have the commitment to devote the time to the tutorial process.
- A good tutor is always interested in helping students to learn better.
- Sufficient resources should be made available for students to take part the PBL tutorial.
- Time management is important.

Assessment of Learning
- It is important for tutors to make sure that assessment is consistent with learning objectives of the groups in PBL
- Assessment of students should not be focused only on the final leaning product.
- PBL tutors need to understand meaningful ways of assessing students' work to motivate learning.
- For assessment to be implemented properly there should be well designed and clearly defined goals and objectives and well thought out strategies, techniques, criteria, and marking schemes.

Student's Role in PBL
- Prepare students for PBL before starting the sessions.
- Students must have ability to initiate the task/idea .they should not be mere imitators.
- They must learn to think.
- Students working in PBL must be responsible for their own learning.
- Throughout the PBL process, students have to define and analyze the problem, generate learning issues and apply what they have learned to solve the problem and act for them-selves and be free.
- Students must quickly learn how to manage their own learning, Instead of passively receiving instruction.
- Students in PBL are actively constructing their knowledge and understanding of the situation in groups.
- Students in PBL are expected to work in groups.
- They have to develop interpersonal and group process skills, such as effective listening or coping creatively with conflicts.

Inquiry Skills
- Students in PBL are expected to develop critical thinking abilities by constantly relating:
- What they read to do?
- What they want to do with that information?
- They need to analyze information presented within the context of finding answers.
- Modeling is required so that the students can observe and build a conceptual model of the required processes.
- Formative and summative questions for evaluation:
- How effective is …….?
- How strong is the evidence for ………?
- How clear is ……?
- What are the justifications for thinking?
- Why is the method chosen?
- What is the evidence given to justify the solution?

Information Literacy
- Information literacy is an integral part of self- directed learning

Information literacy involves the ability to:
- Know when there is a need for information
- Identify the information needed to solve a given problem or issue
- Be able to locate the needed information
- Use the information to solve the given problem effectively.
- Skills required by students in information literacy include:
- How to prepare the search , How to carry out the research,

- Sorting and assessing of information in general

Collaborative learning

- It is an educational approach to teaching and learning that involves
- groups of students working together to solve a problem or complete a project
- In collaborative learning, learners have the opportunity to talk with peers, exchange diverse beliefs present and defend ideas, as well as questioning other ideas.

Interpersonal Skills

- Interpersonal skills relating to group process are essential for effective problem solving and learning.
- It is important that students are made aware of these inter personal skills.
- Consensual decision making skills, Dialogue and discussion skills, Team maintenance skills
- Conflict management skills and Team leadership skills.
  Students who have these skills have a better opportunity to learn than students who do not have these skills and Time Management

Resources

- Students need to have the ability to evaluate the resources used

Students have to evaluate the source of the resources used by asking the following questions:

- How current is it?, Is there any reason to suspect bias in the source?
- How credible and accurate is it?

Meta-cognitive Skills

- Students need to reflect on the processes they are using during the learning process,
- Compare one strategy with another, and evaluate the effectiveness of the strategy used

Reflection Skills

- Reflection helps students refine and strengthen their high-level thinking skills and abilities through self-assessment.
- Reflection gives students opportunities to think about how they answered a question, made a decision, or solved a problem.
- What strategies were successful or unsuccessful? ,What issues need to be remembered for next time? , What could or should be done differently in the future?

Follow the practices learned in Software Engineering course- Requirement Analysis, Designing and Modeling.

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	3	-	-	-	-	-	-	-	-
CO4	-	-	-	-	2	-	-	-	-	-	-	-
CO5	-	-	-	-	-	3	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	-	-	-	2

Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) 217534: Code of Conduct		
Teaching Scheme	**Credit Scheme**	**Examination Scheme and Marks**
Tutorial: **01 Hours/Week**	**01$**	**Term work$:** **25 Marks**

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Preamble:

Engineering is one of the important and cultured professions. With respect to any engineering profession, engineers are expected to exhibit the reasonable standards of integrity and honesty. Engineering is directly or indirectly responsible to create a vital impact on the quality of life for the society. Acceptably, the services provided by engineers require impartiality, honesty, equity and fairness and must give paramount importance to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the principles of ethical conduct.

Prime aim is to recognize and evaluate ethical challenges that they will face in their professional careers through knowledge and exercises that deeply challenge their decision making processes and ethics.

Course Objectives:

- To promote ethics, honesty and professionalism.
- To set standards that are expected to follow and to be aware that If one acts unethically what are the consequences.
- To provide basic knowledge about engineering Ethics, Variety of moral issues and Moral dilemmas, Professional Ideals and Virtues
- To provide basic familiarity about Engineers as responsible Experimenters, Research Ethics, Codes of Ethics, Industrial Standards, Exposure to Safety and Risk, Risk Benefit Analysis
- To have an idea about the Collegiality and Loyalty, Collective Bargaining, Confidentiality, Occupational Crime, Professional, Employee, Intellectual Property Rights.

Course Outcomes:

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

CO1: Understand the basic perception of profession, professional ethics, various moral and social issues, industrial standards, code of ethics and role of professional ethics in engineering field.

CO2: Aware of professional rights and responsibilities of an engineer, responsibilities of an engineer for safety and risk benefit analysis.

CO3: Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

CO4: Acquire knowledge about various roles of engineers in variety of global issues and able to apply ethical principles to resolve situations that arise in their professional lives.

Course Contents

The following are the certain guidelines as far as ethics and code of conduct are concerned to be clearly and elaborately explained to the students,

Fundamental norms Engineers, in the fulfillment of their professional duties, should include paying utmost attention to the safety, health, and welfare of the society. Along with that engineers should execute the services only in their areas of competence. Whenever there is a need to issue public statements then such statements should be expressed in objective and truthful manner. Engineer should extend high sense of integrity by acting for each employer or client as faithful agents or trustees. Whatever may be the working scope engineer should conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

As far as ethical practices are concerned engineers should not reveal facts, data, or information without the prior consent of the client or employer except as authorized or required by

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law or Code. Engineers should not permit the use of their name or associate in business ventures with any person or firm that they believe is engaged in fraudulent or dishonest enterprise moreover he/she should not aid or abet the unlawful practice of engineering by a person or firm.

Engineers having knowledge of any alleged violation of the Code should report thereon to appropriate professional bodies and, when relevant, also to public authorities, and cooperate with the proper authorities in furnishing such information or assistance as may be required. Engineers should disclose all known or potential conflicts of interest that could influence or appear to influence their judgment or the quality of their services. Engineers should not accept compensation, financial or otherwise, from more than one party for services on the same project, or for services pertaining to the same project, unless the circumstances are fully disclosed and agreed to by all interested parties. Engineers should not solicit or accept financial or other valuable consideration, directly or indirectly, from outside agents in connection with the work for which they are responsible.

Engineers should never falsify their qualifications or permit misrepresentation of their or their associates' qualifications. They shall not misrepresent or exaggerate their responsibility in or for the subject matter of prior assignments. Brochures or other presentations incident to the solicitation of employment shall not misrepresent pertinent facts concerning employers, employees, associates, joint ventures, or past accomplishments.

Engineers should not offer, give, solicit, or receive, either directly or indirectly, any contribution to influence the award of a contract by public authority, or which may be reasonably construed by the public as having the effect or intent of influencing the awarding of a contract. They should not offer any gift or other valuable consideration in order to secure work. They should not pay a commission, percentage, or brokerage fee in order to secure work, except to a bona fide employee or bona fide established commercial or marketing agencies retained by them.

There are certain obligations accompanied with engineering profession. Engineers should acknowledge their errors and should not distort or alter the facts. Candid advises in special cases are always welcome. Engineers should not accept outside employment to the detriment of their regular work or interest. Before accepting any outside engineering employment, they will notify their employers.

Engineers should not promote their own interest at the expense of the dignity and integrity of the profession furthermore they should treat all persons with dignity, respect, fairness, and without discrimination. Engineers should at all times strive to serve the public interest. Engineers are encouraged to participate in civic affairs; career guidance for youths; and work for the advancement of the safety, health, and well-being of their community. Engineers are encouraged to adhere to the principles of sustainable development in order to protect the environment for future generations. Engineers shall continue their professional development throughout their careers and should keep current in their specialty fields by engaging in professional practice, participating in continuing education courses, reading in the technical literature, and attending professional meetings and seminar.

Engineers should not, without consent, use equipment, supplies, laboratory, or office facilities of an employer to carry on outside private practice. They should not attempt to injure, maliciously or falsely, directly or indirectly, the professional reputation, prospects, practice, or employment of other engineers. Engineers who believe others are guilty of unethical or illegal practice shall present such information to the proper authority for action. "Sustainable development" is the challenge for the engineers meeting human needs for natural resources, industrial products, energy, food, transportation, shelter, and effective waste management while conserving and protecting environmental quality and the natural resource base essential for future development.

Following are contents to be covered in tutorial session-

1. **Introduction to Ethical Reasoning and Engineer Ethics:** Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas –Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy –Professions and Professionalism – Professional Ideals and Virtues – Uses of Ethical Theories.
2. **Professional Practice in Engineering :** Global Issues -Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development –

Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct

3. **Ethics as Design** - Doing Justice to Moral Problems : Engineer's Responsibility for Safety - Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk

4. **Workplace Responsibilities and Rights** - Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

5. **Computers, Software, and Digital Information**

6. **Responsibility for the Environment**

#Exemplar/Case Studies :

General Motors ignition switch recalls (2014), Space Shuttle Columbia disaster (2003), Space Shuttle Challenger disaster (1986), Therac-25 accidents (1985 to 1987), Chernobyl disaster (1986), Bhopal disaster (1984), Kansas City Hyatt Regency walkway collapse (1981)

Guidelines for Conduction:

The course will exemplify the budding engineers the Code of Conduct and ethics pertaining to their area and scope of their work. The Instructor/Teacher shall explain the students the importance and impact of the ethics and code of conduct.

Confined to various courses and project/mini-project development the possible vulnerabilities and threats need to be elaborated and the students' participation need to be encouraged in designing such document explicitly mentioning Code of Conduct and Disclaimers.

Suggested set of Activities

1. **Purpose-**Introduce the concept of Professional Code of Conduct

   Method – Using Group Discussion as a platform, ask students to share one practice in their family / home that everyone has to follow. For ex. not wearing footwear in the house, taking a bath first thing in the morning, seeking blessings from elders, etc. Connect this Code of Conduct in their family to one that exists in the professional world

   Outcome – Awareness of profession-specific code of conduct and importance of adherence of that code specified. Ability to express opinions verbally and be empathetic to diverse backgrounds and values

2. **Purpose-**Impress upon the students, the significance of morality

   Method – Role play a professional situation where an engineer is not competent and is trying to copy the work of a colleague and claim credit for that work. Ask observing students to react to that situation. Alternatively, a short video that clearly shows unethical behavior can be played and ask viewers their opinion about the situation. Note to teachers – read about Kohlber's theory and Gilligan's theory to understand levels of moral behavior

   Outcome – Incite students to contemplate their own immoral behavior in public space or academic environment (like copying homework or assignment). Will coax students to introspect their own values and encourage them to choose the right path

3. **Purpose**-Highlight the importance of professional ideals like conflict management, ambition, ethical manners and accountability

   Method – Each student will have to write a 200 word essay on any of above mentioned virtues of being a good professional. On evaluation, the top 5 essays can be displayed on the college wall magazine and rewarded if deemed appropriate

   Outcome – Learn to express one's ideas and identify and relate to good virtues. Build writing skills, improve language and gain knowledge about how to write an impactful essay

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4. **Purpose**-Make students aware of proper and globally accepted ethical way to handle work, colleagues and clients

    Method – Teacher can form groups of 6 – 7 students and assign them different cases (these can be accessed online from <u>copyright free</u> websites of B-school content)

    Outcome – Develop group communication skills. Learn to speak up one's opinion in a forum. Cultivate the habit of presenting solution-driven analytical arguments making them contributors in any team.

5. **Purpose** – Make students aware that technology can be harmful if not used wisely and ethically

    Method – Conduct a quiz on various ethical dilemmas that are relevant in today's world pertaining to privacy right, stalking, plagiarism, hacking, weaponizing technology, AI, electronic garbage creating environmental hazard etc

    Outcome – Make students aware of various adverse consequences of technology development and allow them to introspect on how to use technology responsibly.

6. **Purpose** – Expose students to professional situations where engineers must use their skills ethically and for the betterment of society and nation

    Method – Students in groups of 4 can be given an assignment in the earlier session to present in front of the class one specific case where they felt unethical treatment has been meted out to a person by an engineer – either as a witness, advisor, dishonesty, improper skills testimony etc. The group has to make a short presentation and also suggested plausible solutions to that situation. Q&A from other students must encouraged to allow healthy discussion

    Outcome – Become aware of unethical code of conduct in the professional world and how to follow a moral compass especially when one reaches positions of power.

7. **Purpose** – Provide an insight into rights and ethical behavior.

    Method – Movies like The Social Network can be played and students can be asked to discuss their opinion about collegiality, intellectual property, friendship and professional relationships

    Outcome – help them look at success stories from an ethical point of view. Develop critical thinking and evaluation of circumstances.

8. **Purpose** – Make students contemplate about ideal and safe professional environment and decide on making right decisions based on codes of conduct

    Method – Students can be asked to write down 5 most important codes of conduct that they feel that every computer engineer should follow. After evaluation by teacher / experts, the collection of codes can be converted into a handbook to be given to every student as a memoir to help them in their professional life.

    Outcome – Introspection and think about how to shape the professional environment. Also, when they carry back with them their own codes of conduct, they could feel bound to adhere to these ethics.

Term Work Assessment Guidelines

Students must submit the report of all conducted activities. The brief guidelines for report preparations are as follows:

1. One activity report must be of maximum 3 pages;
2. Combined Report of all activities with cover pages, table of contents and certificate (signed by instructor) is to be submitted in soft copy (pdf) format only.
3. The report must contain:
   - General information about the activity;
   - Define the purpose of the activity;
   - Detail out the activities carried out during the visit in chronological order;
   - Summarize the operations / process (methods) during the activities;
   - Describe what you learned (outcomes) during the activities as a student;
   - Add photos of the activity;(optional)
   - Add a title page to the beginning of your report;
   - Write in clear and objective language; and
   - Get well presented, timely and complete report submitted.

Recommended Assessment and Weightage Parameters:

(Attendance 30%, Assignments/Activities- Active participation and proactive learning 50% and report 20%)

Term Work Assessment Guidelines

Students must submit the report of all conducted activities conducted during Tutorial (Outside Classroom) of at least 04 activities (out of 07 activities) from 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. Combined Report of all activities with cover pages, table of contents and certificate (signed by instructor) is to be submitted in soft copy (pdf) format only.

3. The report must contain:

- General information about the activity;
- Define the purpose of the activity;
- Detail out the activities carried out during the visit in chronological order;
- Summarize the operations / process (methods) during the activities;
- Describe what you learned (outcomes) during the activities as a student;
- Add photos of the activity;(optional)
- Add a title page to the beginning of your report;
- Write in clear and objective language; and
- Get well presented, timely and complete report submitted.

Recommended Assessment and Weightage Parameters:

(Attendance 30%, Active participation and proactive learning 50% and report 20%)

Web Links:

- https://www.ieee.org/about/compliance.html
- https://www.cs.cmu.edu/~bmclaren/ethics/caseframes/91-7.html
- https://www.nspe.org/
- http://www.ewh.ieee.org/soc/pes/switchgear/presentations/tp_files/2017-1_Thurs_Shiffbauer_Singer_Engineering_Ethics.pdf

MOOC/ Video lectures available at:

- https://swayam.gov.in/nd1_noc20_mg44/preview

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	2	2	-	-	-	-
CO2	-	-	-	-	-	-	2	2	-	-	-	-
CO3	-	-	-	-	-	-	3	2	-	-	-	-
CO4	-	-	-	-	-	-	2	3	-	-	-	-
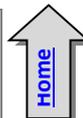
Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217535: Audit Course 4

In addition to credits, it is recommended that there should be audit course in preferably in each semester starting from second year in order to supplement student's knowledge and skills. Student will be awarded the bachelor's degree if he/she earns specified total credits [1] and clears all the audit courses specified in the syllabus. The student will be awarded grade as AP on successful completion of audit course. The student may opt for one of the audit courses per semester, starting in second year first semester. Though not mandatory, such a selection of the audit courses helps the learner to explore the subject of interest in greater detail resulting in achieving the very objective of audit course's inclusion. List of options offered is provided. Each student has to choose one audit course from the list per semester. Evaluation of audit course will be done at institute level itself. Method of conduction and method of assessment for audit courses are suggested.

Criteria:

The student registered for audit course shall be awarded the grade AP (Audit Course Pass) and shall be included such AP grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself. [1]

Guidelines for Conduction and Assessment (Any one or more of following but not limited to):

- Lectures/ Guest Lectures
- Visits (Social/Field) and reports
- Demonstrations
- Surveys
- Mini-Project
- Hands on experience on focused topic

Course Guidelines for Assessment (Any one or more of following but not limited to):
- Written Test
- Demonstrations/ Practical Test
- Presentations, IPR/Publication and Report

Audit Course 4 Options

Audit Course Code	Audit Course Title
217535-I	Water Management
217535-II	Intellectual Property Rights and Patents
217535-III	The Science of Happiness
217535-IV	Stress Relief: Yoga and Meditation
217535-V	Foreign Language (one of Japanese/Spanish/French/German) Course contents for **Japanese(Module 2)** are provided. For other languages institute may design suitably.

Note: It is permitted to opt one of the audit courses listed at SPPU website too, if not opted earlier. [1]
http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202017/Forms/AllItems.aspx
http://www.unipune.ac.in/university_files/syllabi.htm

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Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217535-I: Water Management

Water is a vital resource for all life on the planet. Only three percent of the water resources on Earth are fresh and two-thirds of the freshwater is locked up in ice caps and glaciers. One fifth of the remaining one percent is in remote, inaccessible areas. As time advances, water is becoming scarcer and having access to clean, safe, drinking water is limited among countries. Pure water supply and disinfected water treatment are prerequisites for the well-being of communities all over the world. One of the biggest concerns for our water-based resources in the future is the sustainability of the current and even future water resource allocation. This course will provide students a unique opportunity to study water management activities like planning, developing, distributing and optimum use of water resources. This course covers the topics that management of water treatment of drinking water, industrial water, sewage or Wastewater, management of water resources, management of flood protection.

Course Objectives
- To develop understanding of water recourses.
- To study global water cycle and factors that affect this cycle.
- To analyze the process for water resources and management.
- To study the research and development areas necessary for efficient utilization and management of water recourses.

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

CO1: Understand the global water cycle and its various processes

CO2: Understand climate change and their effects on water systems

CO3: Understand Drinking treatment and quality of groundwater and surface water

CO4: Understand the Physical, chemical, and biological processes involved in water treatment and distribution.
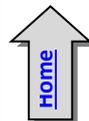
Course Contents

1. Understanding 'water'-Climate change and the global water cycle, understanding global hydrology
2. Water resources planning and management-Water law and the search for sustainability: a comparative analysis, Risk and uncertainty in water resources planning and management
3. Agricultural water use -The role of research and development for agriculture water use
4. Urban water supply and management - The urban water challenge, Water sensitive urban design

References:

1. R. Quentin Graft, Karen Hussey, Quentin Graft, Karen Hussey, Publisher, "Water Resources Planning and Management", Cambridge University Press, ISBN: 9780511974304, 9780521762588.
2. P. C. Basil, "Water Management in India", ISBN: 8180690970, 2004.
3. C.A. Brebbia, "Water Resources Management", ISBN: 978-1-84564-960-9, 978-1-84564-961-6.

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	1	-	-	-	-	-
CO2	-	-	-	-	-	-	2	-	-	-	-	1
CO3	-	-	-	-	-	-	1	-	-	-	-	-
CO4	-	-	-	-	-	2	2	-	-	-	-	2

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217535-II: Intellectual Property Rights and Patents

Intellectual property is the area of law that deals with protecting the rights of those who create original works. It covers everything from original plays and novels to inventions and company identification marks. The purpose of intellectual property laws is to encourage new technologies, artistic expressions and inventions while promoting economic growth.

Innovation and originality have great potential value. Whatever line of activity you are engaged in, future success depends on them. The last few years have seen intellectual property rights become an issue of general interest: the smart phone "patent wars", the introduction of Digital Rights management (DRM) and the rise of generic pharmaceuticals and open-source software are just some examples that have been in the public eye. Protecting your intellectual rights appropriately should be at a priority. Yet too many people embark on their chosen professions without even a basic awareness of intellectual property.

Course Objectives:
- To encourage research, scholarship, and a spirit of inquiry
- To encourage students at all levels to develop patentable technologies.
- To provide environment to the students of the Institute for creation, protection, and commercialization of intellectual property and to stimulate innovation.

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

CO1: **Understand** the fundamental legal principles related to confidential information, copyright, patents, designs, trademarks and unfair competition

CO2: **Identify, apply** and **assess** principles of law relating to each of these areas of intellectual property

CO3: **Apply** the appropriate ownership rules to intellectual property you have been involved in creating

Course Contents

1. **IntroductiontoIntellectualPropertyLaw–**TheEvolutionaryPast-TheIPRToolKit-Para-Legal Tasks in Intellectual Property Law
2. **Introduction to Trade mark –** Trade mark Registration Process – Post registration Procedures -Trade mark maintenance - Transfer of Rights – Inter parties Proceeding – Infringement - Dilution Ownership of Trade mark
3. **Introduction to Copyrights –** Principles of Copyright Principles -The subjects Matter of Copy right – The Rights Afforded by Copyright Law – Copy right Ownership, Transfer and duration – Right to prepare Derivative works
4. **IntroductiontoTradeSecret–**MaintainingTradeSecret–PhysicalSecurity– EmployeeLimitation - Employee confidentiality agreement

Reference:
1. Debirag E. Bouchoux, "Intellectual Property" Cengage learning, New Delhi, ISBN-10:1111648573
2. Ferrera, Reder, Bird, Darrow, "Cyber Law. Texts and Cases", South-Western's Special Topics Collections,ISBN:0-324-39972-3
3. Prabhuddha Ganguli, "Intellectual Property Rights", Tata Mc-Graw–Hill, NewDelhi,ISBN-10:0070077177

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	1	-	-	-	1
CO2	-	-	-	-	-	-	-	2	-	-	-	1
CO3	-	-	-	-	-	-	-	1	-	-	-	1

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217535-III: The Science of Happiness

Everybody wants to be happy. One can explore innumerable ideas about what happiness is and how we can get some. But not many of those ideas are based on science. That's where this course comes in. The subject "Science of Happiness" aims to teach the pioneering science of positive psychology, which explores the ancestry of a happy and meaningful life. Clinical psychologists have been dealing with miserable feelings since their discipline was established. In the last 30 years, neuroscientists have made major headway in the understanding of the sources of anger, depression, and fear.

Today, whole industries profit from this knowledge—producing pills for every sort of pathological mood disturbance. But until recently, few neuroscientists focused on the subject of happiness. This course focuses on discovering how cutting-edge research can be applied to their lives. Students will learn about the Intra-disciplinary research supporting this view, spanning the fields of psychology, neuroscience, evolutionary biology, and beyond. The course offers students practical strategies for tapping into and nurturing their own happiness, including trying several research-backed activities that foster social and emotional well-being, and exploring how their own happiness changes along the way.

Course Objectives
- To understand the feeling of happiness
- To study the sources of positive feelings
- To analyze the anatomy of the happiness system
- To study the effect of thoughts and emotions on the happiness system

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

CO1: Understand what happiness is and why it matters to you

CO2: Learn how to increase your own happiness

CO3: Understand of the power of social connections and the science of empathy

CO4: Understand what is mindfulness and its real world applications

Course Contents
1. Happiness: what is it? , 2. The secret of smiling
3. The autonomy of positive feelings
4. Positive feelings as a compass
5. The happiness system
6. Foundations: Emotions, Motivation and nature of Wellbeing
7. Subjective well being
8. Love and well being
9. Optimal well being
10. Religion, Spirituality and wellbeing

References:
1. Happier, Stefan Klein, "The Science of Happiness, How Our Brains Make Us Happy and what We Can Do to Get", Da Capo Press, ISBN 10: 156924328X, 13: 978-1569243282.
2. C. Compton, Edward Hoffman, "Positive Psychology: The Science of Happiness and Flourishing", William, Cengage Learning, 2012, ISBN10: 1111834121.

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	1	-	-	-	-	-	-	-	1
CO2	-	-	-	1	-	-	-	-	-	-	-	2
CO3	-	-	-	-	-	-	1	-	1	-	-	2
CO4	-	-	-	-	-	-	-	-	-	-	-	2

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217535-IV: Yoga and Meditation

The concepts and practices of Yoga originated in India about several thousand years ago. Its founders were great Saints and Sages. The great Yogis presented rational interpretation of their experiences of Yoga and brought about a practical and scientifically sound method within every one's reach. Yoga today, is no longer restricted to hermits, saints, and sages; it has entered into our everyday lives and has aroused a worldwide awakening and acceptance in the last few decades. The science of Yoga and its techniques have now been reoriented to suit modern sociological needs and lifestyles.

Yoga is one of the six systems of Vedic philosophy. The Yoga advocates certain restraints and observances, physical discipline, breathe regulations, restraining the sense organs, contemplation, meditation and Samadhi. The practice of Yoga prevents psychosomatic disorders and improves an individual's resistance and ability to endure stressful situations.

Course Objectives:

- To impart knowledge about the basic technique and practice of yoga, including instruction in breath control, meditation, and physical postures
- To gain an intellectual and theoretical understanding of the principles embodied in the Yoga Sutras, the Bhagavad-Gita, and other important texts and doctrines
- Relaxation and stress reduction ,Personal insight and self understanding, Personal empowerment, Gaining wisdom and spiritual discernment
- Awakening the abilities or powers of the Super conscious mind

Course Outcomes:

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

CO1: Understand philosophy and religion as well as daily life issues will be challenged and enhanced.

CO2: Enhances the immune system.

CO3: Intellectual and philosophical understanding of the theory of yoga and basic related Hindu scriptures will be developed.

CO4: Powers of concentration, focus, and awareness will be heightened.

Course Contents

1. Meaning and definition of yoga – Scope of Yoga - Aims and Objectives of Yoga – Misconception about yoga.
2. Ayurveda: an introduction to this system of health care derived from the Vedic tradition Anatomy and Physiology as they relate to Yoga
3. Yoga Philosophy and Psychology

References:

1. B.K.S. Iyengar, "BKS Iyengar Yoga The Path to Holistic Health" , DK publisher, ISBN-13: 978-1409343479
2. Osho, "The Essence of Yoga", Osho International Foundation, ISBN: 9780918963093

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	-	2	-	-	2	-	-	-
CO2	-	-	-	-	-	2	1	-	-	-	-	-
CO3	-	2	-	-	-	2	-	-	-	-	-	-
CO4	-	2	-	-	-	-	-	2	-	-	-	-

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217535-V: Foreign Language (Japanese) Module 2

W ith changing times, the competitiveness has gotten into the nerves and 'Being the Best' at all times is only the proof of it. Nonetheless, 'being the best' differs significantly from 'Communicating the best'! The best can merely be communicated whilst using the best… suited Language!!

Course Objectives:
- To meet the needs of ever growing industry with respect to language support.
- To get introduced to Japanese society and culture through language.

Course Outcomes:

On completion of the course learner will-
1. have ability of basic communication.
2. have the knowledge of Japanese script.
3. get introduced to reading , writing and listening skills
4. develop interest to pursue professional Japanese Language course

Course Contents

1. Katakana basic Script, Denoting things (nominal and pre nominal demonstratives), Purchasing at the Market / in a shop / mall (asking and stating price)
2. Katakana : Modified kana, double consonant, letters with ya, yu, yo, Long vowels, Describing time, describing starting and finishing time (kara ~ made), Point in time (denoting the time when any action or the movement occurs)
3. Means of transport (Vehicles), Places, Countries, Stating Birth date, Indicating movement to a certain place by a vehicle.

References:
1. Minna No Nihongo, "Japanese for Everyone", (Indian Edition),   Goyal Publishers and Distributors Pvt. Ltd.
2. http://www.tcs.com   (http://www.tcs.com/news_events/press_releases/Pages/TCS-Inaugurates- Japan-centric-Delivery-Center-Pune.aspx)

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	1	3	1	1
CO2	-	-	-	-	1	-	-	-	-	3	1	1
CO3	-	-	-	-	1	-	-	-	-	3	2	2
CO4	-	-	-	-	-	-	-	-	-	1	-	1

Acknowledgement

It is with great pleasure and honor that I share the curriculum for Second Year of Artificial Intelligence and Data Science (2020 Course) on behalf of Board of Studies (BoS), Computer Engineering. We, members of BoS are giving our best to streamline the processes and curricula design at both UG and PG programs.

It is always the strenuous task to balance the curriculum with the blend of core courses, current developments and courses to understand social and human values. By considering all the aspects with adequate prudence the contents are designed satisfying most of the necessities as per AICTE guidelines and to make the graduate competent enough as far as employability is concerned. I sincerely thank all the minds and hands who work adroitly to materialize these tasks. I really appreciate everyone's contribution and suggestions in finalizing the contents.

Success is sweet. But it's sweeter when it's achieved thorough co-ordination, cooperation and collaboration. I am overwhelmed and I feel very fortunate to be working with such a fabulous team- the Members of Board of Studies, Computer Engineering!

Even in these anxious situation, during the time of this unfortunate pandemic, each and every person, including the course coordinators and their team members, have worked seamlessly to come up with this all inclusive curriculum for Second Year of Computer Engineering.

Thank you to all of you for delivering such great teamwork. I don't think it would have been possible to achieve the goal without each and every one of your efforts! I would like to express my deep gratitude to **Dr. Prashant Yawalkar (MET, Nashik),** member BoS, Computer Engineering, for coordinating the complete activity and getting it to completion in a smooth manner.

I deeply appreciate and thank the managements of various colleges affiliated to SPPU for helping us in this work. These colleges have helped us by arranging sessions for preliminary discussion in the initial stage and at the same time in conducting Faculty Development Programs for various courses of the revised curriculum. All your support is warmly appreciated.

I sincerely appreciate, the hard work put in by the course coordinators and their team members, without your intellectual work and creative mind, and it would have not been possible to complete this draft. You have been a valuable member of our team!

Special thanks are due to Dr. Parikshit Mahalle, Dr. Swati Bhavsar and Dr. Jayashri Prasad for helping with the formatting and crisp presentation of this draft. I would like to thank you from the core of my heart. Thank you for always being your best selves and contributing to the work.

I am thankful to **Dr. Nuzhat Shaikh,** for the time she has spent in critically reading the draft and giving the final touches. I appreciate her initiative and thank her for her time, patience and hard work!

Thank you all, for not only your good work but also for all the support you have given each other throughout the drafting process, that's what makes the team stronger! You took the meaning of teamwork to a whole new level.

Thank you for all your efforts!

Professor (Mrs.) Dr. Varsha H. Patil, Chairman, and
Members- Dr. Shirish Sane, Dr. Sunil Bhirud, Dr. Manik Dhore, Dr. Pramod Patil, Dr. Girish Khilari, Dr. Sachin Lodha, Dr. Parikshit Mahalle, Dr. Venkatesharan, Dr. Geetanjali Kale, Dr. Suhasini Itkar, Dr. R. V. Patil and Dr. P. M. Yawalkar.
Board of Studies (BoS), Computer Engineering, Faculty of Science and Technology, Savitribai Phule Pune University.

Task Force at Curriculum Design

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2. Team Leader-Dr. Prashant M. Yawalkar

3. Teams, Course Design-

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