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

http://unipune.ac.in

Curriculum

For

Second Year of Computer Science and Engineering (Data Science)

(2019 Pattern)

(With effect from A.Y. 2024-25)

Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
(With effect from 2024-25)

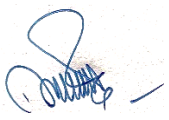
Prologue

Data science is an interdisciplinary field of computer engineering that uses scientific methods, processes, algorithms, and systems to extract knowledge and insights from structured and unstructured data. It has gained a lot of attention in last decade. It is with great pleasure and honor to share the syllabi for Second Year of Computer Science and Engineering in Data Science (2019 Course) on behalf of Board of Studies, Computer Engineering. We, members of BoS are giving our best to streamline the processes and curricula design.

While designing the syllabus for this programme, honest and sincere efforts are put to tune Computer Science and Engineering in Data Science program syllabus in tandem with the objectives of Higher Education of India, AICTE, UGC and affiliated University (SPPU) by keeping an eye on the technological advancements and industrial requirements globally.

Active participation and expert opinions and suggestions from domain professionals added value to the contents. Sincere efforts have been put by members of BoS, teachers, alumni, industry experts in framing the draft with guidelines and recommendations. Case Studies are included in almost all courses. Course Instructor is recommended to discuss appropriate related recent technology/upgrade/Case Studies to encourage students to study from course to the scenario and think through the largest issues/ recent trends/ utility/ developing real world/ professional skills.

I am sincerely indebted to all the minds and hands who work adroitly to materialize these tasks. I really appreciate your contribution and suggestions in finalizing the contents.



Dr. Nilesh J. Uke
Chairman, Board of Studies (Computer Engineering), SPPU, Pune

Table of Contents

Savitribai Phule Pune University Bachelor of Computer Science and Engineering (Data Science)		
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, Machine Learning, Artificial Intelligence, Web Applications, Big Data Analytics and Networking for efficient design of computer-based systems of varying complexity.	
PSO2	**Problem-Solving Skills** The ability to apply standard practices and strategies in software/embedded 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 a zest for higher studies.	

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
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Semester-III

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	In-Sem	End-Sem	Term work	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
210641	Mathematical Foundation for Data Science -I	03	-	01	30	70	-	-	-	100	03	--	-	03
210642	Data Structures & Algorithms	03	-	-	30	70	-	-	-	100	03	-	-	03
210643	Object Oriented Programming (OOP)	03	-	-	30	70	-	-	-	100	03	-	-	03
210644	Digital Electronics and Logic Design	03	-	-	30	70	-	-	-	100	03	-	-	03
210645	Software Engineering and Project Management	03	-	-	30	70	-	-	-	100	03	-	-	03
210646	Data Structures & Algorithms Laboratory	-	04	-	-	-	25	25	-	50	-	02	-	02
210647	Object Oriented Programming (OOP) Laboratory	-	04	-	-	-	25	25	-	50	-	02	-	02
210648	Digital Electronics and Computer Architecture Laboratory	-	02	-	-	-	25	-	25	50	-	01		01
210649	Business Communication Skills	-	02	-	-	-	25	-	-	25	-	01	-	01
210650	Humanity and Social Science	-	-	01	-	-	25	-	-	25	-	-	01	01
210651	Audit Course 3													
										Total Credits	**15**	**06**	**01**	**22**
	Total	**15**	**12**	**02**	**150**	**350**	**125**	**50**	**25**	**700**	**-**	**-**	**-**	**-**

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
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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
210652	Mathematical Foundation for Data Science -II	03	-	-	30	70	-	-	-	100	03	--	-	03
210653	Operating Systems	03	-	-	30	70	-	-	-	100	03	-	-	03
210654	Data Storytelling and Visualization	03	-	-	30	70	-	-	-	100	03	-	-	03
210655	Database Management System	03	-	-	30	70	-	-	-	100	03	-	-	03
210656	Computer Graphics	03	-	-	30	70	-	-	-	100	03	-	-	03
210657	Computer Graphics Laboratory	-	04	-	-	-	25	25	-	50	-	02	-	02
210658	Database Management System Laboratory	-	04	-	-	-	25	50	-	75	-	02	-	02
210659	Project Based Learning II	-	04	-	-	-	50	-	-	50	-	02	-	02
210660	Code of Conduct	-	-	01	-	-	25	-	-	25	-	-	01	01
210661	Audit Course 4													
										Total Credits	**15**	**06**	**01**	**22**
	Total	**15**	**12**	**01**	**150**	**350**	**125**	**75**	**-**	**700**	**-**	**-**	**-**	**-**

SEMESTER-III

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General Guidelines

1. Outcome-based education is targeted at achieving desirable outcomes (in terms of knowledge, skills, attitudes and behavior etc.) at the end of program. Teaching this awareness and making the associated effort constitutes outcome-based education. This entails a regular methodology for ascertaining the attainment of outcomes and benchmarking these against the **Program Outcomes (POs)** consistent with objective of program. 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. These Program Outcomes 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, Course Outcomes and CO-PO Mapping Matrix are provided for reference and these are indicative only. The course instructor may modify them as per his or her perspective.
2. For each unit, content attainment mapping is indicated with course outcome(s). Instructor may update the same.
3. @ CO & PO (Course Objectives and Program Outcomes) Attainment Mapping Table: The CO-PO mapping in the table 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 meaning of '-' is no correlation between CO and PO.
4. Exemplar/Case Studies are included at each unit to explore how the learned topics applies to real world situations and are to be designed so as to assist students to increase their understanding of particular skills, content or knowledge in any given situation and articulate. One or two sample exemplar or case study are included for each unit, instructor may extend the same with more.
5. Exemplar/Case Studies may be assigned as self-study by students and to be excluded from theory examinations.
6. 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 the part of laboratory work. Inclusion of it will 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.
7. 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.
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. Set of suggested Laboratory assignments is provided for reference. Laboratory Instructor may design suitable set of assignments for respective institute.
10. Laboratory conduction and assessment guidelines are to be strictly followed.
11. **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 bemet and the evidence that will be gathered to demonstrate the achievement of courseoutcomes. 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 aspart 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.

12. **Laboratory Journal-** Program codes with sample output of all performed assignments are tobe 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.

13. **Tutorial** -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.**

14. **Audit Course-** 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.
15. **$**:For courses 210249: Business Communication Skills, 210250: Humanity and Social Science and 210260: 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 registerfor the final proctored exams that come at a fee and attend in-person at designated center onspecified 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%20Regulati ons%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**

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2019 Course) 210641: Mathematical Foundation of Data Science		
Teaching Scheme:	**Credit:**	**Examination Scheme:**
TH: 03 Hours/Week	03	Mid_Semester(TH): 30 Marks End Semester(TH): 70 Marks

Prerequisite Courses, if any: **Basic Mathematics**

Course Objectives:

1. To understand fundamental mathematical concepts in data science including linear algebra, Calculus and Numerical methods applicability in Data Science.
2. To enable the students to understand the properties and applications of various probability functions.
3. To understand basis of descriptive statistics measures and hypothesis. To understand basics of Discrete Mathematics applicability in Data Science.

Course Outcomes:

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

CO1: **Demonstrate** understanding of basic mathematical concepts for data science, relating to linear algebra and calculus.
CO2: **Demonstrate** understanding of basic Probability concepts for data science, Probability Theory
CO3: **Able** to understand Statistical methods applied to data science.
CO4: **Demonstrate** understanding of basic mathematical concepts for data science, relating to Numerical Methods
CO5: **Demonstrate** understanding of Discrete Mathematics applicability in Data Science.

Course Contents

Unit I	**Linear Algebra**	**(08 Hours)**

Introduction to vectors and matrices, Operations on vectors and matrices, Matrix transformations and their applications, Eigenvalues and eigenvectors, Singular Value Decomposition (SVD), Applications of linear algebra in data science.

#Exemplar/Case Studies	Demonstration of dimensionality reduction using eigenvalues and eigenvector (PCA) Discussion of Page rank algorithm using eigenvalues and eigenvector
Mapping of Course Outcomes for Unit I	CO1

Unit II	**Calculus**	**(08 Hours)**

Limits and continuity, Differentiation and its applications, Integration and its applications, Multivariate calculus, Optimization techniques, Applications of calculus in data science.

#Exemplar/Case Studies	Discussion on how calculus is applied at different stages of the project Optimizing Advertising Campaigns.
Mapping of Course Outcomes for Unit II	CO1

Unit III	**Probability Theory**	**(08 Hours)**

Basic probability concepts, Random variables and probability distributions, Expected values and variance, Conditional probability and independence, Common probability distributions, (Bernoulli, Binomial, Poisson, Gaussian), Law of large numbers and central limit theorem

#Exemplar/Case Studies	Discussion on Fraud Detection in Financial Transactions
Mapping of Course Outcomes for Unit III	CO2

Unit IV	**Statistical Inference**	**(08 Hours)**

Point estimation and interval estimation, Hypothesis testing, Parametric and non-parametric tests Goodness-of-fit tests, Confidence intervals, Applications of statistical inference in data science	
#Exemplar/Case Studies	Discussion on Case Study Clinical Trial Analysis for Drug Efficacy using Hypothesis Testing
Mapping of Course Outcomes for Unit IV	CO3

Unit V	**Numerical Methods**	**(06 Hours)**
Root finding methods, Interpolation and extrapolation, Numerical differentiation and integration, Solving systems of linear equations, Optimization algorithms, Applications of numerical methods in data science		
#Exemplar/Case Studies	Discussion on different numerical methods of finding roots, linear equations and optimization algorithms	
Mapping of Course Outcomes for Unit V	CO4	

Unit VI	**Discrete Mathematics**	**Unit VI**
Sets: Naïve Set Theory (Cantorian Set Theory), Axiomatic Set Theory, Set Operations, Cardinality of set, Principle of inclusion and exclusion. Types of Sets**,** relations, and functions, Combinatory and counting techniques, Graph theory and its applications, Propositional and predicate logic, Proof techniques, Applications of discrete mathematics in data science		
#Exemplar/Case Studies	Discussion on set, Web Graph, Google map, Bayes' theorem	
Mapping of Course Outcomes for Unit V	CO5	

Learning Resources

Text Books:

1. Mathematical Foundations of Big Data Analytics by Vladimir Shikhman , David Müller - Springer
2. Mathematical Foundations for Data Analysis by Jeff M. Phillips Springer Series

Reference Books:

1. Gilbert Strang, "Introduction to Linear Algebra", 5th Edition, Wellesley-Cambridge Press.
2. Thomas' Calculus, 14th Edition, by Joel R. Hass, Christopher E. Heil, Maurice D. Weir
3. Sheldon Ross, "A First Course in Probability", 9th Edition, Pearson
4. Burden, Richard L., and J. Douglas Faires, "Numerical Analysis", 10th Edition, Brooks/Cole.
5. Casella, George, and Roger L. Berger, "Statistical Inference", 2nd Edition, Duxbury Press.
6. Kenneth H. Rosen, "Discrete Mathematics and Its Applications", 8th Edition, McGraw-Hill Education.

MOOC Courses:

1. NPTEL Course "**Discrete Mathematics,"**Prof. Prabuchandran K.J, Prof. SudarshaIyengar (IIT Ropar**)**
   https://nptel.ac.in/courses/106106183
2. NPTEL Course "**Discrete Mathematics, IIT Guwahati** " Prof.Benny George K, Prof. Sajith Gopalan https://nptel.ac.in/courses/106103205
3. NPTEL Course "**Discrete Structures", IIT Kharagpur**Prof. Dipanwita Roychowdhury https://nptel.ac.in/courses/106105192
4. NPTEL Course "**Graph Theory", IIT Madras,**Prof. S.A. Choudum https://nptel.ac.in/courses/111106050

The CO-PO mapping table

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	-	-	-	-	-	-	-	-

CO2	3	3	3	2	-	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	-
CO5	3	3	3	2	-	-	-	-	-	-	-	-
CO6	3	3	3	2	-	-	-	-	-	-	-	-

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
210642: Data Structures & Algorithms

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

Prerequisite Courses, if any: Fundamental knowledge of programming language and basics of algorithms

Companion Course, if any: 210646: Data Structures & Algorithms Laboratory

Course Objectives:

- To study data structures and their implementations and applications.
- To learn different searching and sorting techniques.
- To study some advanced data structures such as trees, graphs and tables.
- To learn different file organizations.
- To learn algorithm development and analysis of algorithms.

Course Outcomes:

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

CO1: Students will be able to explain various data structures, related terminologies and its types.

CO2: Students will be able to handle various operations like searching, insertion, deletion and Traversals on various data structures.

CO3: Students will be able to choose appropriate data structure and apply it to solve problems in various domains tree and graphs.

CO4: Students will be able to analyze and implement appropriate searching techniques for a given problem.

CO5: Students will be able to demonstrate the ability to analyze, design, apply and use data structures to solve engineering problems and evaluate their solutions of files and hashing.

CO6: Students will be able to demonstrate the ability of stack and queue & its operations.

Course Contents

Unit I	Introduction	(07 Hours)

Introduction: Concept of data, Data object, Data structure, Definition of ADT, Data Structure Classification (Primitive and non-primitive, linear and Nonlinear, static and dynamic, persistent and ephemeral data structures.

Algorithms: Frequency count and its importance in analysis of an algorithm, Time complexity & Space complexity of an algorithm Big 'O', 'Ω' and 'Θ' notations,

Sequential Organization: Single and multidimensional array and address calculation.

Linked Organization: Concept of linked organization, Singly Linked List, Doubly Linked List, Circular Linked List (Operations: Create, Display, Search, Insert, Delete)

#Exemplar/Case Studies	**Set Operations and String Operations**
Mapping of Course Outcomes	**CO1**

Unit II	Searching and Sorting	(06 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. Timesort as a hybrid stable sorting algorithm	
Mapping of Course Outcomes	**CO2, CO4**	
Unit III	**Stack & Queue**	**(06 Hours)**
Stack: Concept of stack, Concept of implicit and explicit stack, stack as an ADT using sequential and linked organization, Applications of stack: recursion, converting expressions from infix to postfix or prefix form, evaluating postfix or prefix form. **Queue:** Concept of queues as ADT, Implementation of queue using array and linked organization, Concept of circular queue, double ended queue, Applications of queue: priority queue		
#Exemplar/Case Studies	Reversing a string, balanced parentheses in algebraic expressions, Towers of Hanoi problem, double ended queue as Stack and Queue.	
Mapping of Course Outcomes for Unit III	**CO6**	
Unit IV	**Trees**	**(06 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 inorder threaded binary search tree, in order traversal of in-order threaded binary search tree.		
Mapping of Course Outcomes for Unit IV	**CO3, CO4**	
Unit V	**Graph**	**(06 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.		

Mapping of Course Outcomes	CO3, CO4	
Unit VI	**Hashing and File Organization**	**(06 Hours)**
Hashing: Hash tables and scattered tables: Basic concepts, hash function, characteristics of good hash function, Different key-to-address transformations techniques, synonyms or collisions, collision resolution techniques- linear probing, quadratic probing, rehashing, chaining with and without replacement. **File:** Concept of File, File types and file organization (sequential, index sequential and Direct Access), Comparison of different file organizations.		

#Exemplar/Case Studies	What are the advantages of binary tree and binary search in file handling? Study Hashing techniques for expandable Files
Mapping of Course Outcomes for Unit VI	**CO5**

Learning Resources

Text Books:

1. E. Horowitz, S. Sahni, D. Mehta, "Fundamentals of Data Structures in C++", Galgotia Book Source, New Delhi, 1995, ISBN 16782928 2. Y. Langsam, M. Augenstin, A. Tannenbaum, "Data Structures using C and C++", 2nd Edition, Prentice Hall of India, 2002, ISBN-81-203-1177-9.

2. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Data Structures and Algorithms in Python, Wiley Publication, ISBN: 978-1-118-29027-9

3. Y. Langsam, M. Augenstin, A. Tannenbaum, "Data Structures using C and C++", 2nd Edition, Prentice Hall of India, 2002, ISBN-81-203-1177-9.

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. A. Tharp ,"File Organization and Processing", 2008 , Willey India edition, 9788126518685

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

The CO-PO mapping table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		3	1	2	1	-	-	-	-	-	1
CO2	2	3	1	1	-	-	-	-	-	-	-	1
CO3	1		2	3	1	2	-	-	-	-	-	1
CO4	1	3	2	1	3	-	-	-	-	-	-	1
CO5	2	1	3	1		-	-	1	3	-	-	1
CO6	1	1	2		3	1	2	-	-	3	-	1

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
210643: Object Oriented Programming

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

Prerequisite Courses, if any: (1019107) Fundamentals of Programming Languages, (1431113) Programming and Problem Solving

Companion Course, if any: (210647) OOP Laboratory

Course Objectives:

The course is intended to provide the foundations and in-depth understanding of a modern object- oriented language.

- To learn the object-oriented programming paradigm, 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 like 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	OOP Fundamentals	(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 specifies, separating interface from implementation. Functions- Function, function prototype, accessing function and utility function, Constructors and destructor, Types of constructors, Objects and

Memory requirements, Static members: variable and functions, inline function, friend function.

#Exemplar/Case Studies	Story on 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, 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	popular software's developed using C++: Firefox and Thunderbird
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	use of C++ SDKs wrappers for Java and .Net
Mapping of Course Outcomes for Unit III	CO2, CO3, CO4

Unit IV	**Files and Streams**	**(06 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 of the features used for MS Office, Internet Explorer and Visual Studio.
Mapping of Course Outcomes for Unit IV	CO2, CO4

Unit V	**Exception Handling & 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 non-type parameters, template and friends Generic Functions, The type name and export keywords**.**

#Exemplar/Case Studies	Use of exception handling in Symbian Operating System (discontinued Mobile OS) that was developed using C++.
Mapping of Course Outcomes for Unit V	CO2, CO4, CO6

Unit VI	**STL: Standard Template Library**	**(06 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 V	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 CHI", fourth edition, Sams Publishing, ISBN:0672323087

Reference Books:

1. Herbert Schildt, "C++-The complete reference"II, Eighth Edition, McGraw Hill Professional, 2011
2. Matt Weisfeld, "The Object-Oriented Thought Process", Third Edition Pearson
3. E.Balagurusamy, "Object-Oriented Programming with C++", Graw-Hill Publication
4. Cox Brad, Andrew J. Novobilski, "Object —Oriented Programming: An Evolutionary Approachl, Second Edition

MOOC Courses:

1. https://onlinecourses.nptel.ac.in/noc24_cs44/preview
2. https://www.classcentral.com/course/freecodecamp-object-oriented-programming-oop-in-c- course-104967
3. https://www.mygreatlearning.com/academy/learn-for-free/courses/oops-concepts-in-c

The CO-PO mapping table

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 Computer Science and Engineering (Data Science)
(2019 Course)
210644: Digital Electronics and Logic Design

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

Prerequisite Courses, if any: 104010 Basic Electronics Engineering

Companion Course, if any: 210648 Digital Electronics Laboratory

Course Objectives:

To learn and understand basic digital design techniques.

To develop design and implementation skills of combinational logic circuits.

To develop design and implementation skills of combinational and sequential logic circuits. To introduce programmable logic devices and ASM chart and synchronous state machines. To understand the functionalities, properties and applicability of Logic Families.

To learn and understand basics of microprocessor.

Course Outcomes:

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

CO1: Spectacle an awareness and apply knowledge of number systems, Boolean algebra and codes.

CO2: Use logic function representation for simplification with K-Maps and analyse as well as design Combinational logic circuits using SSI & MSI chips.

CO3: Analyse Sequential circuits like Flip-Flops (Truth Table, Excitation table), their conversion & design the applications.

CO4: Develop simple real-world application using ASM and PLD.

CO5: Choose appropriate logic families IC packages as per the given design specifications.

CO6: Explain organization and architecture of computer system

Course Contents

Unit I	INTRODUCTION TO DIGITAL ELECTRONICS	(06 Hours)

Introduction to digital electronics & Boolean algebra.

Signed Binary number representation and Arithmetic: Sign Magnitude, 1's complement & 2's complemen representation, unsigned Binary arithmetic (addition, subtraction, multiplication, and division), subtraction using 2's complement;

Logic minimization: Representation of logic functions: logic statement, truth table, SOP form, POS form; Minimization of SOP and POS forms, don't care Conditions and Quine Mc-Clusky Method

Codes: Binary , BCD, octal , hexadecimal , Excess-3 , Gray code & their conversions

#Exemplar/Case Studies	1) Practical applications of various codes in computers 2) four basic arithmetic operations using floating point numbers in a calculator. 3) Digital locks using logic gates
Mapping of Course Outcomes	C01

Unit II	COMBINATIONAL LOGIC DESIGN	(06 Hours)

Design using SSI chips: Code converters, Half- Adder, Full Adder, Half Subtractor, Full Subtractor, n bit Binary adder, Look ahead carry generator, Magnitude comparator using IC 7485

Introduction to MSI chips: Multiplexer (IC 74153, IC 74151), Demultiplexer (IC 74138), Decoder (74238) Encoder (IC 74147), Binary adder (IC 7483)

Design using MSI chips: BCD adder & subtractor using IC 7483, Implementation of logic functions using IC 74153 & 74138.

Parity generators and checker

#Exemplar/Case Studies	Combinational Logic Design of BCD to 7-segment display Controller
Mapping of Course Outcomes for Unit II	CO1, CO2

Unit III	SEQUENTIAL LOGIC DESIGN	(06 Hours)
Introduction to sequential circuits: Difference between combinational circuits and sequential circuits; Memory element-latch & Flip-Flop. **Flip- Flops:** Logic diagram, truth table & excitation table of SR, JK, D, T flip flops; Conversion from one FF to another , Study of flip flops with regard to asynchronous and synchronous, Preset & Clear, Master Slave configuration ; Study of 7474, 7476 flip flop ICs. **Application of flip-flops:** Counters- asynchronous, synchronous and modulo n counters, study of 7490 modulus n counter ICs & their applications to implement mod counters; Registers- shift register types (SISO, SIPO, PISO &PIPO)& applications **Synchronous Sequential Circuit Design:**Models- Moore and Mealy, State diagram and State Table , Design Procedure, Sequence Generator and detector.		
#Exemplar/Case Studies	Electronic Voting Machine (EVM)	
Mapping of Course Outcomes for Unit III	CO1, CO3	
Unit IV	**PROGRAMMABLE LOGIC DEVICES AND ALGORITHMIC STATE MACHINES**	**(06 Hours)**
Introduction to PLD's: ROM, PAL, PLA, Design of 4 variable SOP using PLDs, Basic architecture of SPLD and CPLD, Study of CPLD architecture XC9572, Basic architecture of FPGA, CPLD. Design flow (Basic Concept of Simulation and Synthesis) **Algorithmic State Machines:** Finite State Machines (FSM) and ASM, ASM charts (eg- counters, washing machine, lift controller, vending machine), Notations, construction of ASM chart and realization for sequential circuits. **Introduction to HDL –** Necessity, Characteristics & Types.		
#Exemplar/Case Studies	Wave form generator using MUX controller method	
Mapping of Course Outcomes for Unit IV	CO3, CO4	
Unit V	**LOGIC FAMILIES**	**(06 Hours)**
Classification of logic families: Unipolar and Bipolar Logic Families, Characteristics of Digital ICs: Fan-in, Fan-out, Current and voltage parameters, Noise immunity, Propagation Delay, Power Dissipation, Figure of Merits, Operating Temperature Range, power supply requirements. Transistor-Transistor Logic: Operation of TTL NAND Gate (Two input), TTL with active pull up, TTL with open collector output, Wired AND Connection, Tristate TTL Devices, TTL characteristics. CMOS: CMOS Inverter, CMOS characteristics, CMOS configurations- Wired Logic, Open drain outputs.		
#Exemplar/Case Studies	To study the various basic gate design using TTL/CMOS logic family	
Mapping of Course Outcomes for Unit V	CO5	
Unit VI	**INTRODUCTION TO COMPUTER ARCHITECTURE**	**(06 Hours)**
Introduction to Ideal Microprocessor – Data Bus, Address Bus, Control Bus. Microprocessor based Systems – Basic Operation, Microprocessor operation, Block Diagram of Microprocessor. Functional Units of Microprocessor – ALU using IC 74181, Basic Arithmetic operations using ALU IC 74181, 4-bit Multiplier circuit using ALU and shift registers. Memory Organization and Operations, digital circuit using decoder and registers for memory operations.		
#Exemplar/Case Studies	Microprocessor based system in Communication /Instrumentation Control	
Mapping of Course Outcomes for Unit VI	CO2, CO3, CO6	
Learning Resources		

Text Books:

1. "Modern Digital Electronics ", R.P. Jain, 3rd Edition, Tata McGraw-Hill, ISBN: 0–07– 049492–4
2. "Digital Logic applications and Design" John Yarbrough, Cengage Learning, ISBN – 13: 978-81-315-0058-3

Reference Books:

1"Digital Principles", Flyod, Pearson Education, ISBN:978-81- 7758-643-6.

2. "Digital Design", M Morris Mano, Prentice Hall, 3rd Edition, ISBN: 0130621218.
3. "Digital Logic applications and Design", John Yarbrough, Thomson Publication, ISBN: 978- 0314066756
4. "Digital Principles and Applications", Malvino, D. Leach, 5th edition, Tata McGraw Hill

MOOC Courses:

1. Digital Circuits, by Prof. Santanu Chattopadhyay, https://swayam.gov.in/nd1noc19ee51/preview
2. Digital Circuits and Systems, Prof. S. Srinivasan https://nptel.ac.in/courses/117/106/117106086/

The CO-PO mapping table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	-	-	-	-	-	-	-	-	2
CO2	3	1	3	-	-	-	-	-	-	-	-	1
CO3	3	1	3	-	-	-	-	-	-	-	-	-
CO4	3	-	2	1	-	-	-	-	-	-	-	-
CO5	3	-	-	-	1	-	-	-	-	-	-	-
CO6	3	-	-	-	-	-	-	-	-	-	-	1

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
210645: 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)

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 for WebApps, Validation Testing, Validation-Test Criteria, Configuration Review.

Suggested Free Open Source Tools: Selenium, JUnit.

#Exemplar/Case Studies	Selenium 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 Engineeringand 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 Computer Science and Engineering (Data Science)
(2019 Course)
210645: Data Structures & Algorithms Laboratory

Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 Hrs. / week	02	Practical: 25 Marks Term work: 25 Marks

Prerequisite Courses, if any: Fundamental knowledge of programming language and basics of algorithms.

Companion Course, if any:

Course Objectives

- To **understand** practical implementation and usage of nonlinear 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

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

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), University syllabus, conduction & Assessment guidelines, topics under consideration- concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Laboratory Journal

1. 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 & 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.
2. **Program codes with sample output of all performed assignments are to be submitted as softcopy.**
3. 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.
4. 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 is done based on overall performance and Laboratory assignments performance of student. 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, 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, and E. Each student must perform at least 12 assignments as at least 02 from group A, 03 from group B, 03 from group C, 2 from group D, 02 from group E. **Operating System recommended:** - 64-bit Open-source Linux or its derivative **Programming tools recommended**: - Open-Source Python, C++ Programming tool like G++/GCC, Jupyter Notebook, PyCharm, Spyder.

Suggested List of Laboratory Experiments/Assignments	
Sr. No.	**Group A**
1.	Write a P**ython** program to store marks scored in "First year Engineering" by N students. 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 exam d) Display mark with highest frequency
2.	Write a **Python** program for college 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.
3.	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
4.	Write a **python** program for sparse matrix realization and operations on it- Transpose, Fast Transpose and addition of two matrices

5.	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

Sr. No.	Group B
6.	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 OR Binary search and Fibonacci search
7.	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) and Fibonacci search. Insert friend if not present in phonebook
8.	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.
9.	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
10.	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.
Sr. No.	**Group C**
11.	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.
12.	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.
13.	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.

14.	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 beginning of the list (which will make it relatively easy to retrieve the highest item.)

15.	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.
Sr. No.	**Group D**
16.	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.
17.	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
18.	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.
19.	A Dictionary stores keywords & 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.
Sr. No.	**Group E**
20.	Implement a program for maintaining a database of student records using Files. Student has Student_id,name, Roll_no, Class, marks and address. Display the data for few students. 1. Create Database 2. Display Database 3. Delete Records 4. Update Record
21.	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)

22.	To create ADT that implement the "set" concept. a. Add (newElement) -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

@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 Computer Science and Engineering (Data Science)
(2019 Course)
210646: Object Oriented Programming Laboratory

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

Companion Course, if any: Object Oriented Programming

Course Objectives: To learn various object-oriented programming language concepts, principles of OOP, syntax and semantics, file handling, exceptions and standard Templates.

Course Outcomes:

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

CO1: Apply (L3) constructs: sequence, selection and iteration: classes & objects, inheritance, use of predefined classes from libraries while developing a software

CO2: Design (L6) object-oriented solutions for small systems involving multiple objects. CO3: Use (L4) virtual and pure virtual function and complex programming situations CO4: Apply (L3) object-oriented software principles in problem solving

CO5: Analyse (L4) the strengths of object-oriented programming

CO6: Develop (L6) the application using object-oriented programming language C++.

Guidelines for Instructors 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), curriculum of the course, conduction and Assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/guidelines, and references.

Guidelines for Students 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 jointly by the internal examiner and 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. 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 CH Programming tool like G++/GCC, OPENGL

Instructor is suggested to design assignments list by selecting/designing at least 10 suitable assignments from group A, B, and C. Select at least 5 from group A, 4 from group B, 1 from group C. It is also advised for instructor to encourage students and demonstrate installation of open-source operating system (fedora or Linux etc.)

	Suggested List of Assignments
	GROUP A
1	Implement a class Complex which represents the Complex Number data type. Implement the following operations: 1. Constructor (including a default constructor which creates the complex number 0+0i). 2. Overloaded operator+ to add two complex numbers. 3. Overloaded operator* to multiply two complex numbers. 4. Overloaded << and >> to print and read Complex Numbers.
2	Implement a class Quadratic that represents degree two polynomials i.e., polynomials of type ax2 +bx+c. The class will require three data members corresponding to a, b and c. Implement the following operations: 1. A constructor (including a default constructor which creates the 0 polynomial). 2. Overloaded operator+ to add two polynomials of degree 2. 3. Overloaded << and >> to print and read polynomials. To do this, you will need to decide what you want your input and output format to look like. 4. A function eval that computes the value of a polynomial for a given value of x. 5. A function that computes the two solutions of the equation ax2 +bx+c=0
3	Implement a class Cpp Array which is identical to a one-dimensional C++ array (i.e., the index set is a set of consecutive integers starting at 0) except for the following: 1. It performs range checking. 2. It allows one to be assigned to another array through the use of the assignment operator (e.g. cp1= cp2) 3. It supports a function that returns the size of the array. 4. It allows the reading or printing of array through the use of cout and cin

4	Write a C++ program create a calculator for an arithmetic operator (+, -, *, /). The program should take two operands from user and performs the operation on those two operands depending upon the operator entered by user. Use a switch statement to select the operation. Finally, display the result. Some sample interaction with the program might look like this: Enter first number, operator, second number: 10 / 3 Answer = 3.333333 Do another (y/n)? y Enter first number, operator, second number: 12 + 100 Answer = 112 Do another (y/n)? n

5	Develop an object oriented program in C++ to create a database of student information system containing the following information: Name, Roll number, Class, division, Date of Birth, Blood group, Contact address, telephone number, driving licence no. etc Construct the database with suitable member functions for initializing and destroying the data viz constructor, default constructor, Copy constructor, destructor, static member functions, friend class, this pointer, inline code and dynamic memory allocation operators-new and delete.
6	Create a class template to represent a generic vector. Include following member functions: • To create the vector. • To modify the value of a given element • To multiply by a scalar value • To display the vector in the form (10,20,30,…)
7	Create a class Rational Number (fractions) with the following capabilities: a) Create a constructor that prevents a 0 denominator in a fraction, reduces or simplifies fractions that are not in reduced form and avoids negative denominators. b) Overload the addition, subtraction, multiplication and division operators for this class. c) Overload the relational and equality operators for this class
8	Imagine a publishing company which does marketing for book and audiocassette versions. Create a class publication that stores the title (a string) and price (type float) of a publication. 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
9	Write a function in C++ to count and display the number of lines not starting with alphabet 'A' present in a text file "STORY.TXT". Example: If the file "STORY.TXT" contains the following lines, “The roses are red. A girl is playing there. There is a playground. An aeroplane is in the sky. Numbers are not allowed in the password.” The function should display the output as 3

10	Write C++ Program with base class convert declares two variables, val1 and val2, which hold the initial and converted values, respectively. It also defines the functions getinit( ) and getconv( ), which return the initial value and the converted value. These elements of convert are fixed and applicable to all derived classes that will inherit convert. However, the function that will actually perform the conversion, compute( ), is a pure virtual function that must be defined by the classes derived from convert. The specific nature of compute( ) will be determined by what type of conversion is taking place.

11	A book shop maintains the inventory of books that are being sold at the shop. The list includes details such as author, title, price, publisher and stock position. Whenever a customer wants a book, the sales person inputs the title and author and the system searches the list and displays whether it is available or not. If it is not, an appropriate message is displayed. If it is, then the system displays the book details and requests for the number of copies required. If the requested copies book details and requests for the number of copies required. If the requested copies are available, the total cost of the requested copies is displayed; otherwise, the message ―Required copies not in stock‖ is displayed. Design a system using a class called books with suitable member functions and Constructors. Use new operator in constructors to allocate memory space required. Implement C++ program for the system
12	Create employee bio-data using following classes i) Personal record ii) Professional record iii) Academic record Assume appropriate data members and member function to accept required data & print bio-data. Create bio-data using multiple inheritance using C++.
	GROUP B
13	Crete User defined exception to check the following conditions and throw the exception if the criterion does not meet. a. User has age between 18 and 55 b. User stays has income between Rs. 50,000 – Rs. 1,00,000 per month c. User stays in Pune/ Mumbai/ Bangalore / Chennai d. User has 4-wheeler Accept age, Income, City, Vehicle from the user and check for the conditions mentioned above. If any of the condition not met then throw the exception
14	Write a menu driven program that will create a data file containing the list of telephone numbers in the following form John 23456 Ahmed 98763 …….. …… Use a class object to store each set of data, access the file created and implement the following tasks I. Determine the telephone number of specified persons. II. Determine the name if telephone number is known. III. Update the telephone number, whenever there is a change.

15	Write a C++ program that creates an output file, writes information to it, closes the file and open it again as an input file and read the information from the file.
16	Write a C++ program using command line arguments to search for a word in a file and replace it with the specified word. The usage of the program is shown below. $ change <old word> <new word> <file name>
17	Using standard template library (STL) list container implement following member functions of list class: empty, insert, merge, reverse, sort, Unique, using iterator
18	Write a function template selection Sort. Write a program that inputs, sorts and outputs an int array and a float array.
19	You are the owner of a hardware store and need to keep an inventory that can tell you what different tools you have, how many of each you have on hand and the cost of each one. Write a program that initializes the random-access file hardware.dat to 100 empty records, lets you input the data concerning each tool, enables you to list all your tools, lets you delete a record for a tool that you no longer have and lets you update any information in the file. The tool identification number should be the record number. Use the

	following information to start your file: Record # Tool name Quantity Cost 3 Electric sander 7 57.98 17 Hammer 76 11.99 24 Jig saw 21 11.00 39 Lawn mower 3 79.50 56 Power saw 18 99.99
GROUP C	
20	Develop a Supermarket Billing System using C++. The key features of this application are listed below: • Bill Report: It shows the bill report of all the items added in supermarket billing system. • Add, Remove or Edit items: With this feature one can add, remove and modify item details. In add items, one can add Information or details such as item no., item name, manufacturing date, price, quantity, tax percent, and many more. • Show item details: This feature allows users to see the items and the corresponding details given for the item while adding the item. Use file to store the data
21	Design an E-mail Verifier which accepts the email address from the user. Depending upon the input given by user display appropriate results. Use the following concepts in the Project – Constructor, Destructor, new, delete, exceptional handling, string handling functions, etc.

22	Design and Develop Library Management system using OOP Concepts.
23	Design and develop the Tic-Tac-Toe Game using C++

The CO-PO mapping table

	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 Computer Science and Engineering (Data Science)
(2019 Course)
210648: Digital Electronics and Logic Design Laboratory

Teaching Scheme:	Credit:	Examination Scheme:
Practical: 02 Hrs. / week	01	Oral: 25 Marks Term work: 25 Marks

Prerequisite Courses, if any: Basic Electronics Engineering

Companion Course, if any: Digital Electronics and Logic Design

Course Objectives:

- To learn and understand basic digital design techniques.
- To learn and understand design and construction of combinational and sequential circuits.

Course Outcomes:

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

CO1: Understand the working of digital electronic circuits.

CO2: Apply the knowledge to appropriate IC as per the design specifications.

CO3: Design and **implement** Sequential and Combinational digital circuits as per the specifications.

Guidelines for Instructor's Manual

The faculty member should prepare the laboratory manual for all the experiments and it should be made available to students and laboratory instructor/assistant. The instructor's manual should include prologue, university syllabus, conduction& Assessment guidelines, topics under consideration concept, objectives, outcomes, algorithms, sample test cases, data sheets of various elements of computer system, ICs, tools 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, circuit diagram, pin configuration, conclusion/analysis).

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.

Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work is done based on overall performance and Laboratory Performance of student. Each Laboratory assignment assessment should assign 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, efficiency, 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. Student should perform at least 12 experiments with all experiments from group A and any 5 assignments from group B and one from group C assignments.

Virtual Laboratory:

- **http://vlabs.iitb.ac.in/vlabs-dev/labs/dldgates/index.html**
- **http://vlabs.iitb.ac.in/vlabs-dev/labs/dldesignlab/index.html**

Suggested List of Laboratory Experiments/Assignments	
Sr. No.	**Group A**
1.	To Realize Full Adder/ Subtractor using a) Basic Gates and b) Universal Gates
2.	Design and implement Code Converters- BCD to Excess-3
3.	Design and Realization of BCD Adder using 4-bit Binary Adder (IC 7483).
4.	Realization of Boolean Expression for suitable combination logic using MUX 74151 /74153, DMUX 74154/74138
5.	To Verify the truth table of two bit comparators using logic gates.
6.	Design and Implement Parity Generator and checker using EX-OR.
	Group B
7.	Design and Realization: Flip Flop conversion.
8.	Design and implement 2 bit and 3 bit Ripple Counter using master slave JK flip-flop IC 7476.
9.	Design and implement Synchronous 3 bit Up and Down Counter using master slave JK flip-flop IC 7476.
10.	Design and implement Modulo 'N' counter using IC7490. (N= 100 max).
11.	Design and implement Sequence generator (for Prime Number/odd and even) using MS JK flip-flop.
12.	Design and implement Sequence detector using MS JK flip-flop.
	Group C
13.	Study of Shift Registers (SISO, SIPO, PISO, PIPO)
14.	14 Design of ASM chart using MUX controller Method
Student should submit term work in the form of a journal based on the above assignments. Note - Instructor should take care that datasheets of all the required ICs are available in the laboratory& students will be able to verify the functionality of ICs being used.	

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
210649: Business Communication Skills

Teaching Scheme	Credit Scheme	Examination Scheme and Marks Term Work
Practical: 02 Hours/Week	01[$]	[$]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 behavioral 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 assignment. 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.
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 Computer Science and Engineering (Data Science) (2019 Course) 210649: Humanities and Social Science		
Teaching Scheme	**Credit Scheme**	**Examination Scheme and Marks Term Work**
Tutorial: 01 Hours/Week	01	Term Work - 25 Marks

Prerequisite Courses, if any: No prerequisites required

Course Objectives:

- 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 able to–

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.

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

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-judgemental 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 how to present using technological tools
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

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 BEHAVIOUR

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 nonverbal 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 BEHAVIOUR

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 nonverbal 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 & 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 behaviour 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 behaviour 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-soprivileged members of our society have to endure to survive and go beyond their 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

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 & 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, Behavioural Science : Achieving Behavioural Excellence for Success, Wiley

The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	3	2	2	-	-	-
CO2	-	-	-	-	-	-	3	-	-	-	-	-
CO3	-	-	-	-	-	-	-	2	3	-	-	1
CO4	-	-	-	-	-	-	3		2	-	-	-
CO5	-	-	-	-	-	-	-	3	-	-	-	-
CO6	-	-	-	-	-	-	-	-	-	-	-	-

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
210651: 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
AC3-I	Green Construction and Design
AC3-II	Social Awareness and Governance Program
AC3-III	Environmental Studies
AC3-IV	Smart Cities
AC3-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

AC3-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 Ai 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%20Rati ng %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	-	-	-	-	-

AC3-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", .
2. Bhagabati Prosad Banerjee, Durga Das Basu, Shakeel Ahmad Khan, V. R. Manohar, "Introduction to the Constitution of India", ISBN : 9788180385599.

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO1	-	-	-	-	-	-	-	2	-	-	-	-
CO2	-	-	-	-	-	-	-	3	2	-	-	-
CO3	-	-	-	-	-	-	-	2	2	-	-	-
CO4	-	-	-	-	-	-	-	1	1	-	-	-

AC3-III: Environmental Studies

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

@The CO-PO Mapping Matrix

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

AC3-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

AC3-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 language.

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	PO 12
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 Computer Science and Engineering(Data Science)
(2019 Course)
210651 : Mathematical Foundation-II of Data Science

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

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives:

1. To learn various concepts of multivariable calculus.
2. To study real analysis principles such as limits, continuity, and convergence to establish a rigorous mathematical framework for data analysis and modelling.
3. To study linear regression techniques to model relationships between variables, assess model performance, and make predictions based on data sets with multiple predictors.
4. To learn time series analysis methods for modelling and forecasting sequential data, including trend analysis, seasonality decomposition, and autoregressive models.
5. To learn foundational concepts of machine learning, including supervised and unsupervised learning algorithms.
6. To study optimization techniques such as gradient descent, stochastic gradient descent, and convex optimization

Course Outcomes:

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

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

CO1: Understand solving multivariable calculus problems.

CO2: Apply real analysis concepts to analyse the convergence and continuity of functions used in data science models, ensuring robustness and reliability of analytical results.

CO3: Implement linear regression models to analyse relationships between variables, interpret model coefficients, and make accurate predictions based on real-world data sets.

CO4: Utilize time series analysis techniques to identify patterns, trends, and anomalies in sequential data, and develop predictive models for time-dependent phenomena.

CO5: Apply machine learning algorithms to classify data, cluster similar data points, and extract meaningful insights from large and complex data sets in various domains.

CO6: Use optimization techniques to fine-tune machine learning models, minimize cost functions, and optimize model parameters for improved performance and efficiency in data analysis tasks.

Course Contents

Unit I	Multivariable Calculus	(08 Hours)

Derivate: Types of Partial derivatives and gradients, Multiple integrals and applications, Vector calculus (divergence, curl, gradient), Line and surface integrals, Theorems of Green, Gauss, and Stokes, Applications of multivariable calculus in data science

#Exemplar/Case Studies	Discussion on backpropagation, Green's theorem
Mapping of Course Outcomes for Unit I	CO1

Unit II	Real Analysis	(08 Hours)

Set Theory: Sets, sequences, and series, Continuity and differentiability of functions, Riemann integration Convergence and uniform convergence, Taylor and Fourier series, Applications of real analysis in data science

#Exemplar/Case Studies	Discussion on Time-series forecasting, Monte Carlo simulation methods, analyze genomic sequences

Mapping of Course Outcomes for Unit II	CO2	
Unit III	**Linear Regression**	**(08 Hours)**
Linear Regression: Simple linear regression, Multiple linear regression, Assessing model fit and diagnostics, Residual analysis, Variable selection techniques, Applications of linear regression in data science		
#Exemplar/Case Studies	Discussion on Forecasting sales, Predicting housing prices	

Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**Time Series Analysis**	**(08 Hours)**
Time Series: Types of time series, Stationarity and autocorrelation, ARIMA models, Seasonal decomposition, Forecasting techniques, Model evaluation, Applications of time series analysis in data science		
#Exemplar/Case Studies	Predicting monthly website traffic, temperature recordings in a city	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	**Machine Learning Foundations**	**(06 Hours)**
Machine learning Types, Supervised and unsupervised learning, Classification and regression algorithms, Clustering algorithms, Model evaluation techniques, Bias-variance tradeoff, Applications of machine learning in data science		
#Exemplar/Case Studies	Discussion on Email spam classification, Credit risk assessment in finance	
Mapping of Course Outcomes for Unit V	CO5	
Unit VI	**Optimization Techniques**	**(10 Hours)**
Optimization types, Convex optimization, Gradient descent methods, Constrained optimization, Meta-heuristic optimization algorithms, Applications of optimization techniques in data science		
#Exemplar/Case Studies	Portfolio optimization in finance, Parameter tuning in machine learning models	
Mapping of Course Outcomes for Unit V	CO6	

Learning Resources

Text Books:

1. Mathematical Foundations of Big Data Analytics by Vladimir Shikhman , David Müller - Springer
2. Mathematical Foundations for Data Analysis by Jeff M. Phillips Springer Series

Reference Books:

1. James Stewart, "Calculus: Early Transcendentals", 8th Edition, Cengage Learning.
2. Walter Rudin, "Principles of Mathematical Analysis", 3rd Edition, McGraw-Hill Education.
3. James Fox, "Applied Regression Analysis and Generalized Linear Models", 3rd Edition, SAGE Publications.
4. Tsay, Ruey S., "Analysis of Financial Time Series", 4th Edition, Wiley.
5. Hastie, Trevor, Robert Tibshirani, and Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", 2nd Edition, Springer
6. An Introduction to Optimization (Wiley Series in Discrete Mathematics and Optimization) by Edwin K. P. Chong, Stanislaw H. Zak - Wiley Publication

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

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Scienc (2019 Course) 210652: Operating System		
Teaching Scheme:	**Credit:**	**Examination Scheme:**
TH: 03 Hours/Week	03	Mid_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses, if any:
Computer Organization and Architecture

Course Objectives:

1. To introduce basic concepts and functions of operating systems.
2. To understand the concept of process, thread management and scheduling.
3. To learn the concept of concurrency control.
4. To study various Memory Management techniques.
5. To know the concept of I/O and File management.
6. To explain the key concepts that comprise computer security.

Course Outcomes:

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

CO1: Explain the role and functions of Operating Systems.
CO2: Apply the concepts of process and thread scheduling.
CO3: Illustrate the concept of process synchronization, mutual exclusion and the deadlock.
CO4: Analyze various memory management techniques for efficient memory allocation. **CO5:** Apply different techniques of I/O management, Disk management, Disk scheduling and file system structure in operating systems
CO6: Explain Importance of computer security.

Course Contents

Unit I	OPERATING SYSTEM OVERVIEW	(06 Hours)

Operating System: Objectives and Functions-process management, memory management, storage management, protection and security, distributed systems. The Evolution of Operating Systems, Developments Leading to Modern Operating Systems, Types of operating systems, Open-Source Operating Systems

Mapping of Course Outcomes for Unit I	CO1

Unit II	PROCESS MANAGEMENT	(06 Hours)

Process: Concept of a Process, Process States, Process Description, Process Control (Process creation, Waiting for the process/processes, Loading programs into processes and Process Termination), Execution of the Operating System.
Process Scheduling: Types of Schedulers ,Scheduling criteria, Types of Scheduling, FCFS – SJF – RR , Multilevel Queue Scheduling, Multilevel Feedback Queue Scheduling
Threads: Processes and Threads, Concept of Multithreading, Types of Threads

Mapping of Course Outcomes for Unit II	CO2

Unit III	CONCURRENCY CONTROL	(06 Hours)

Process/thread Synchronization and Mutual Exclusion: 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
Deadlock: Principles of Deadlock, Deadlock Modeling, Strategies to deal with deadlock: The Ostrich Algorithm, Deadlock Prevention, Deadlock Avoidance, Deadlock detection and recovery, An Integrated Deadlock Strategy.

Case Studies	Dining Philosophers Problem
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, Page table structure, Segmentation
Virtual Memory: Background, Demand Paging, Page Replacement (FIFO, LRU, Optimal), Allocation of frames, Thrashing

Mapping of Course Outcomes for Unit IV	CO4

Unit V	**INPUT/OUTPUT AND FILE MANAGEMENT**	**(06 Hours)**

I/O Management and Disk Scheduling: I/O Devices, Organization of the I/O Function, I/O Buffering, Disk Scheduling (FIFO, SSTF, SCAN, C-SCAN, LOOK, C-LOOK).
File Management: Overview-Files and File Systems, File structure. File Organization and Access, File Directories, File Sharing, Record Blocking, Secondary Storage Management

Mapping of Course Outcomes for Unit V	CO5

Unit VI	**Computer Security**	**(06 Hours)**

Threats, Attacks, and Assets ,Intruders, Intrusion Techniques, Malicious Software Overview, Multiple-Threat Malware, Viruses, Worms, and Bots, Rootkits Computer security techniques: Authentication , Access Control Discretionary Access Control , Intrusion Detection Basic Principles ,Malware Defence , Dealing with Buffer Overflow Attacks

Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8th Edition,2014, ISBN-10: 0133805913 • ISBN-13: 9780133805918
2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts,John Wiley Sons ,Inc., 9th Edition,2012, ISBN 978-1-118-06333-0

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.

Andrew S. Tanenbaum & Herbert Bos, Modern Operating System, Pearson, ISBN-13: 9780133592221, 4th Edition.

MOOC Courses:

1. https://nptel.ac.in/courses/106106144

The CO-PO mapping table												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	-	-	-	-	-	-	-	-	1
CO2	3	2	1	-	-	-	-	-	-	-	-	1
CO3	3	3	1	-	-	-	-	-	-	-	-	1
CO4	3	3	1	-	-	-	-	-	-	-	-	1
CO5	3	3	1	-	-	-	-	-	-	-	-	1
CO6	3	3	1	-	-	-	-	-	-	-	-	1

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
210653: Data Storytelling and Visualization

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

Prerequisite Courses, if any:
Fundamentals of programming

Course Objectives:

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

Course Outcomes:

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

Course Contents

Unit I	Introduction to data storytelling	(06 Hours)

Need of storytelling, the psychology and anatomy of storytelling, how data is communicated, understanding the target audience, impact of storytelling, Exploring and discovering data, ethics in data storytelling, case studies.

#Exemplar/Case Studies	Discussion on Public opinion shaping in politics, Urban planning and transportation
***Mapping of Course Outcomes for Unit VI**	CO1

Unit II	Designing and delivering the storyline	(06 Hours)

Capturing the insights, valuable insights, focus of data points, evaluation of the data for better insights, defining the structure of the storyline, creation of the storyline for analysis, Format of the story, determining best visualization, selection of appropriate design, Ways of delivering the storyline, the narration, visuals: setting the scenes, polishing the scenes.

#Exemplar/Case Studies	Discussion on Social media sentiment analysis, Geographic data visualization for disaster response
***Mapping of Course Outcomes for Unit VI**	CO2

Unit III	Foundations of Data Visualization	(06 Hours)

Data Pre-processing, Overview of Data Visualization, Need of data visualization, The Human Brain and Data Visualization, The Shapes of Data, Inputs for data visualization, Types of Visualizations: Cognitive vs Perceptual

Design Distinction, Examples of the Types of Visualizations, 5 big data visualization categories: temporal, hierarchical, network, multidimensional and geospatial, Practicing Good Ethics in Data Visualization, Ineffective Visuals and How to Improve Them, Principles of Visual Perception, Color as a Pre-Attentive Attribute, Strategic Use of Contrast, Tools for Visualizing: PowerBI, Tableau etc., case study.	
#Exemplar/Case Studies	Discussion on Customer churn prediction in telecommunications, Financial market dashboard analysis, Public health communication during pandemics
***Mapping of Course Outcomes for Unit VI**	CO3
Unit IV	**Best Practices of Data Visualization** **(06 Hours)**
Gestalt Principle: Proximity, Accessible Visualizations, Aesthetic, Design and Exploratory Analysis Introduction, Exploratory and Explanatory Analysis, Data, Relationships and Design Static Versus Interactive Visualizations, Bringing everything together in a dashboard, Moving from Foundational to Advanced Visualizations: Bar charts, Gantt charts, Stacked bars, Tree maps, Area charts, Pie charts; Visualizing distributions: Circle charts, Jittering, Box and whisker plots, Histograms.	
#Exemplar/Case Studies	Discussion on Social network analysis, Customer segmentation in e-commerce, Project management dashboard.
***Mapping of Course Outcomes for Unit VI**	CO4
Unit V	**ADVANCED VISUALIZATION TECHNIQUES** **(06 Hours)**
Geospatial Visualization Mapping data- Using GIS tools and libraries, Network and Graph Visualization, Visualizing relationships and connections- Node-link diagrams, matrix plots etc., Temporal Visualization, Time-series analysis and visualization, Animation and dynamic visualizations, Hierarchical and Tree Visualization Tree maps, dendograms, etc. Representing hierarchical structures- Multidimensional Visualization, Parallel coordinates, radar charts, etc. Visualizing high-dimensional data-Text and Sentiment Visualization, Word clouds, sentiment analysis, Visualizing textual data- Dashboard Design and Development, Designing interactive dashboards User experience and usability considerations.	
#Exemplar/Case Studies	Environmental monitoring and conservation, Epidemiological analysis and disease surveillance.
***Mapping of Course Outcomes for Unit VI**	CO5
Unit VI	**CASE STUDIES AND APPLICATIONS** **(06 Hours)**
Industry-specific Data Stories- Healthcare, finance, marketing, Ecommerce, Science, Social Media, Challenges and opportunities in different industries, Real-world Data Visualization Projects-Success stories, Innovations and trends in data visualization, Creating and presenting data stories, Emerging Technologies in Data Visualization-Virtual reality, augmented reality, AI and machine learning in visualization, Ethical Considerations in Practice-Avoiding bias and misrepresentation, Ensuring transparency and accountability, Future Trends in Data Storytelling & Visualization, Predictive analytics and forecasting.	

#Exemplar/Case Studies	VR data visualization in automotive design, Bias mitigation in AI-driven hiring.
***Mapping of Course Outcomes for Unit VI**	CO6
Learning Resources	

Text Books:

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

Reference Books:

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

The CO-PO mapping table

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

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
210654: Database Management System

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

Prerequisite Courses, if any: Data structures.

Companion Course, if any: Discrete structures.

Course Objectives:

- To understand the fundamental concepts of Database Management Systems
- To acquire the knowledge of database query languages and transaction processing
- To be familiar with the basic issues of transaction processing and concurrency control.
- To learn and understand various Database Architectures and Applications.
- To understand how analytics and big data affect various functions now and in the future.

Course Outcomes:

On completion of the course, learners should be able to

CO1: Analyze and **design** Database Management System using ER model
CO2: Implement database queries using database languages
CO3: Normalize the database design using normal forms
CO4: Apply concurrency control in real-time situations
CO5: Use large scale databases for processing data processing.
CO6: Understand the impact of analytics and big data on the information industry and the external ecosystem for analytical and data services.

Course Contents

Unit I	Introduction to Database Management Systems and ER Model	(06 Hours)

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

#Exemplar/Case Studies	Analyze and design database using ER Model for any real-time application and convert the same into tables.
Mapping of Course Outcomes for Unit I	CO1

Unit II	SQL and PL/SQL	(07 Hours)

SQL: Characteristics and Advantages, SQL Data Types and Literals, DDL, DML, DCL, TCL, SQL Operators. Tables: Creating, Modifying, Deleting, Updating, SQL DML Queries: SELECT Query and clauses, Index and Sequence in SQL. Views: Creating, Dropping, Updating using Indexes, Set Operations, Predicates and Joins, Set membership, Tuple Variables, Set comparison, Ordering of Tuples, Aggregate Functions, SQL Functions, Nested Queries.PL/SQL: Concept of Stored Procedures and Functions, Cursors, Triggers, Assertions, Roles and Privileges.

#Exemplar/Case Studies	Implementation of Unit 1 case study using SQL and PL/SQL.

Mapping of Course Outcomes for Unit II	CO1, CO2

Unit III	**Relational Database Design**	**(06 Hours)**
Relational Model: Basic concepts, Attributes and Domains, CODD's Rules. Relational Integrity: Domain, Referential Integrities, Enterprise Constraints. Database Design: Features of Good Relational Designs, Normalization, Atomic Domains and First Normal Form, Decomposition using Functional Dependencies, Algorithms for Decomposition, 2NF, 3NF, BCNF.		
#Exemplar/Case Studies	Normalize relational database designed in Unit I.	
Mapping of Course Outcomes for Unit III	CO1, CO3	

Unit IV	**Concurrency Control And Advanced Databases**	**(07 Hours)**
Concurrency Control: Need, Locking Methods, Deadlocks, Time-stamping Methods, and Optimistic Techniques. Recovery Methods: Shadow-Paging and Log-Based Recovery, Checkpoints, Performance Tuning, Query Optimization with respect to SQL Database. **Database Architectures:** Centralized and Client-Server Architectures, 2 Tier and 3 Tier Architecture, Introduction to Parallel Databases, Key elements of Parallel Database Processing, Architecture of Parallel Databases, Introduction to Distributed Databases, Architecture of Distributed Databases, Distributed Database Design.		
#Exemplar/Case Studies	Study of Transaction Management in Postgre SQL	
Mapping of Course Outcomes for Unit IV	CO3, CO4	

Unit V	**Large Scale Data Management**	**(07 Hours)**
Emerging Database Technologies: Introduction to No SQL Databases- Internet Databases, Cloud Databases, Mobile Databases, SQLite Database, XML Databases, MongoDB. **Introduction to Big Data and XML:** DTD, XML Schemas, XQuery, XPath. JSON: Overview, Data Types, Objects, Schema, JSON with Java/PHP/Ruby/Python. Hadoop: HDFS, Dealing with Massive Datasets-Map Reduce and Hadoop.		
#Exemplar/Case Studies	Use of NoSQL databases for processing unstructured data from social media.	
Mapping of Course Outcomes for Unit V	CO5, CO6	

Unit VI	**Data Warehousing and Data Mining**	**(07 Hours)**
Data Warehousing: Introduction, Evolution of Data Warehouse, Characteristics, Benefits, Limitation of Data Warehousing, Architecture and Components of Data Warehouse, Conceptual Models, Data Mart, OLAP. **Data Mining:** Process, Knowledge Discovery, Goals of Data Mining, Data Mining Tasks, Association, Classification, Clustering, Big Data (Terminology and examples).		
#Exemplar/Case Studies	Applications of data warehouse in real time environment.	

Mapping of Course Outcomes for Unit VI	**CO5, CO6**

Learning Resources

Text Books:

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

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

Reference Books:

1. C J Date, "An Introduction to Database Systems", Addison-Wesley, ISBN: 0201144719
2. "The Definitive Guide to MongoDB", David Hows, Peter Membrey, Eelco Plugge, Tim Hawk, Apress, Second Edition.
3. Kevin Roebuck, "Storing and Managing Big Data - NoSQL, HADOOP and More", Emereopty Limited, ISBN: 1743045743, 9781743045749
4. Joy A. Kreibich, "Using SQLite", O'REILLY, ISBN: 13:978-93-5110-934-1
5. Ivan Bayross, "SQL, PL/SQL the Programming Language of Oracle", BPB Publications ISBN: 9788176569644, 9788176569644

MOOC Courses:

1. NPTEL Course "Database Management System", Link of the Course: https://nptel.ac.in/courses/106105175
2. NPTEL Course "Database Management System", Link of the Course: https://nptel.ac.in/courses/106104135

The CO-PO mapping table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	1	-	-	-	1	-	-	-	3
CO2	-	2	3	-	-	2	-	-	-	-	-	3
CO3	-	2	3	-	1	-	-	-	-	-	-	3
CO4	2	2	2	2	-	-	-	-	-	1	-	3
CO5	-	2	3	-	-	-	-	-	-	-	1	3
CO6	2	2	-	-	-	-	1	-	2	-	1	1

Savitribai Phule Pune University Second Year of Computer Science and Engineering (Data Science) (2019 Course) 210655: Computer Graphics		
Teaching Scheme:	**Credit:**	**Examination Scheme:**
TH: 03 Hours/Week	03	Mid_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses, if any: Basic Geometry, Trigonometry, Vectors and Matrices, Data Structures and Algorithms

Companion Course, if any: Computer Graphics Laboratory

Course Objectives:

1. Understand the foundations of computer graphics: hardware systems, math basis, light and color.
2. Understand the complexities of modeling realistic objects through modeling complex scenes using a high-level scene description language.
3. Become acquainted with some advanced topics in computer graphics. The student should gain an expanded vocabulary for discussing issues relevant to computer graphics (including both the underlying mathematics and the actual programming).
4. The student should gain an appreciation and understanding of the hardware and software utilized in constructing computer graphics applications.
5. The student should gain a comprehension of windows, clipping and view-ports in relation to images displayed on screen.
6. The student should gain an understanding of geometric, mathematical and algorithmic concepts necessary for programming computer graphics.

Course Outcomes:

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

CO1: Define basic terminologies of Computer Graphics, interpret the mathematical foundation of the concepts of computer graphics and apply mathematics to develop Computer programs for elementary graphic operations.

CO2: Define the concept of windowing and clipping and apply various algorithms to fill and clip polygons.

CO3: Explain the core concepts of computer graphics, including transformation in two and three dimensions, viewing and projection.

CO4: Explain the concepts of color models, lighting, shading models and hidden surface elimination.

CO5: Describe the fundamentals of curves, fractals, animation. CO6: Perceive the concepts of gaming and virtual reality.

Course Contents

Unit I	Computer Graphics Basic, OpenGL and Scan Conversion Algorithms	(06 Hours)

Introduction CG: Introduction to computer graphics, basics of graphics systems, raster and random scan, basic display processor

OpenGL: Introduction – Graphics function, OpenGL Interface, primitives and attributes, Control functions, programming events. (Simple Interaction with the Mouse and Keyboard) **Scan conversion:** Line drawing algorithms: Digital Differential Analyzer (DDA), Bresenham. Circle drawing algorithms: DDA, Bresenham, and Midpoint.

Character Generation: Stroke principle, starburst principle, bitmap method. Introduction to aliasing and anti-aliasing.

#Exemplar/Case Studies	Study about OpenGL Architecture Review Board (ARB)

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

Unit II	**Polygon, Windowing and Clipping**	**(06 Hours)**

Polygons: Polygons and its types, inside test,
Polygon filling methods: Seed Fill – Flood fill and Boundary Fill, Scan-line Fill algorithms,
Windowing: Concept of window and viewport, viewing transformations
Line Clipping: Cohen Sutherland method of line clipping
Polygon Clipping: Sutherland Hodgeman method for convex and concave polygon clipping, Weiler Atherton Polygon Clipping algorithm

#Exemplar/Case Studies	Study use of transformations and projections in education and training software's.
Mapping of Course Outcomes for Unit II	**CO2**

Unit III	**2D, 3D Transformations and Projections**	**(06 Hours)**

2D Transformations: Translation, Scaling, Rotation, Reflection and Shearing, Matrix representation and homogeneous coordinate system, composite transformations, rotation about an arbitrary point.
3D Transformation: Translation, scaling, rotation about X, Y, Z & arbitrary axis, and reflection about XY, YZ, XZ & arbitrary plane.
Projections: Types of projections- Parallel, Perspective
Parallel: oblique – Cavalier, Cabinet, Orthographic – isometric, diametric, trimetric
Perspective: vanishing points as 1 point, 2 point and 3 point.

#Exemplar/Case Studies	Study use of transformations and projections in education and training software's.
Mapping of Course Outcomes for Unit III	**CO2 and CO3**

Unit IV	**Light, Colour, Shading and Hidden Surfaces**	**(06 Hours)**

Color Models: Light sources, Properties of Light, CIE Chromaticity Diagram, Color Gamut, RGB, CMY, YCbCr, HSVcolor models.
Illumination models:, Ambient light, diffuse light, specular reflection, the Phong model, combine diffuse and specular reflections with multiple light sources, warn model
Shading Algorithms: Constant intensity shading, Halftone, Gourand and Phong Shading.
Hidden Surfaces Introduction: Back face detection and removal, Algorithms: Depth buffer (z), Depth sorts (Painter), Area subdivision (Warnock)

#Exemplar/Case Studies	Best practices in Day lighting& Passive Systems for Smaller Commercial Buildings
Mapping of Course Outcomes for Unit IV	**CO4**

Unit V	**Curves, fractals and Animation**	**(06 Hours)**

Curves: Introduction, Interpolation and Approximation, Blending function, B-Spline curve, Bezier Curve.
Fractals: Introduction, Classification, Fractal generation: snowflake, Triadic curve, Hilbert curve, Applications.
Animation: Basics of animation, types of animation, principles of animation, design of animation sequences, animation languages, key frame, morphing, motion specification.
Methods of controlling animation, frame-by-frame animation techniques, real-time animation techniques.

#Exemplar/Case Studies	Study of any open-source tools. a. Unity/Maya/Blender
Mapping of Course Outcomes for Unit V	**CO5**

Unit VI	**Introduction to Gaming and Virtual Reality**	**(06 Hours)**

Gaming: Introduction, Gaming platform (NVIDIA, i8060), Advances in Gaming

Introduction of Virtual Reality: Fundamental Concept, Three I's of virtual reality and Classic Components of VR systems, Applications of VR systems.

Multiple Modals of Input and Output Interface in Virtual Reality: Input – 3D position Trackers and its types, Navigation and Manipulation Interfaces, Gesture Interfaces, Graphics Displays – HMD and CAVE, Sound Displays, Haptic Feedback

#Exemplar/Case Studies	Virtual reality in aviation and Space travel Training
Mapping of Course Outcomes for Unit V	**CO6**

Learning Resources

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. Grigore C. Burdea, Philippe Coiffet, "Virtual Reality Technology", second edition, Wiley India Edition, ISBN 81-265-0789-6

Reference Books:

1. D. Rogers-Procedural Elements for Computer Graphics, 2nd Edition, Tata McGraw-Hill Publication, 2001, ISBN 0 – 07 – 047371 – 4
2. J. Foley, V. Dam, S. Feiner, J. Hughes, ―Computer Graphics Principles and Practice‖, 2nd Edition, Pearson Education, 2003, ISBN 81 – 7808 – 038 – 9.
3. F.S. Hill JR, "Computer Graphics Using Open GL", Pearson Education.

The CO-PO mapping table

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

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
210656: Computer Graphics Laboratory

Teaching Scheme:	Credit	Examination Scheme:
Practical: 02 Hrs. / week	01	Oral: 25 Marks Term work: 25 Marks

Prerequisite Courses, if any: -
Basic Geometry, Trigonometry, Vectors and Matrices, Data Structures and Algorithms

Companion Course, if any:

Course Objectives:

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: Define basic terminologies of Computer Graphics, interpret the mathematical foundation of the concepts of computer graphics and apply mathematics to develop Computer programs for elementary graphic operations.
CO2: Define the concept of windowing and clipping and apply various algorithms to fill and clip polygons.
CO3: Explain the core concepts of computer graphics, including transformation in two and three dimensions, viewing and projection.
CO4: Explain the concepts of color models, lighting, shading models and hidden surface elimination.
CO5: Describe the fundamentals of curves, fractals, animation and gaming.

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 & 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 & 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.

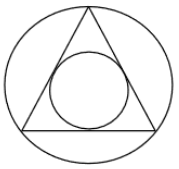
Guidelines for Laboratory Conduction

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:

- **https://cse18-iiith.vlabs.ac.in/**
- **http://vlabs.iitb.ac.in/vlabs-dev/labs/cglab/index.php**

Suggested List of Laboratory Experiments/Assignments

Sr. No.	Group A
1.	Install and explore the OpenGL.
2.	Draw the polygons by using the mouse. Choose colors by clicking on the designed color pane. Use window port to draw. (Use DDA algorithm for line drawing).
3.	Write C++ program to Implement Bresenham circle drawing algorithm to draw any object. The object should be displayed in all the quadrants with respect to center and radius. Ex. 
4.	Write C++ program to draw a 4X4 chessboard. Use DDA and Bresenham‘s drawing algorithm to draw lines. Use Seed fill algorithm to fill black squares of the board
5.	Write C++ program to draw a concave polygon and fill it with desired color using scan fill algorithm.
6.	Write C++ program to implement Cohen Sutherland Hodgman algorithm to clip any given polygon. Provide the vertices of the polygon to be clipped and pattern of clipping interactively.
Sr. No.	**Group B**
7.	Write C++ program to implement translation, rotation and scaling transformations on equilateral triangle and rhombus.
8.	Write C++ program to draw any object such as flower, waves using Bezier Curve generation technique.
9.	Write C++ program to generate fractals using basic concepts of Object oriented programming
Sr. No.	**Group C**
10.	Animation : Implement any one of the following animation assignments, a. Clock with pendulum b. National Flag hoisting c. Vehicle/boat locomotion

	d. Falling Water drop into the water and generated waves after impact,
11.	a) Design and simulate any data structure like stack, queue, and trees 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 one axis. OR c) Write OpenGL program to draw Sun Rise and Sunset.
12.	a) Write a C++ Program control a ball using arrow keys. OR b) Write a C++ Program to implement bouncing ball using sine wave form. OR c) Write C++ program to draw Man Walking in the Rain with an Umbrella. OR d) Write a C++ Program to make puzzle game. OR e) Write a C++ Program to make Tic Tac Toe game.
Mini-Projects/ Case Study	
Design and implement game / animation clip / Graphics Editor using open source graphics library.	

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
210657: Database Management Systems Lab

Teaching Scheme:	Credit:	Examination Scheme:
Practical: 04 Hrs. / week	02	Oral: 25 Marks Term work: 25 Marks

Prerequisite Courses, if any:

Companion Course, if any: Database Management System

Course Objectives:

- To develop Database programming skills
- To develop basic Database administration skills
- To develop skills to handle NoSQL database
- To learn, understand and execute process of software application development

Course Outcomes:

On completion of the course, learners will be able to
CO1: Design E-R Model for given requirements and convert the same into database tables
CO2: Design schema in appropriate normal form considering actual requirements
CO3: Implement SQL queries for given requirements, using different SQL concepts
CO4: Implement PL/SQL Code block for given requirements
CO5: Implement NoSQL queries using MongoDB
CO6: Design and develop application considering actual requirements and using database concepts

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), curriculum of the 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 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.
Problem statements must be decided jointly by the internal examiner and 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. 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 ormini-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: - MYSQL/Oracle, MongoDB, ERD plus, ER Win

List of Laboratory Experiments

Group A- Database Programming Languages–SQL

1. Design and develop SQL DDL statements which demonstrate the use of SQL objects such as Table,View, Index, Sequence and Synonym
2. Design and develop SQL queries for suitable database application using SQL DML statements: Insert, Select, Update and Delete with operators and functions.
3. Design and develop at least 5 SQL queries for suitable database application using SQL DMLstatements: all types of Join and Sub-Query.

Group B- Database Programming Languages – PL / SQL

4. Write a Stored Procedure namely calculate fine for the following requirements:-

   Schema:

   Borrower (Roll no., Name, Date of Issue, Name of Book, Status)Fine

   (Roll no, Date, Amt.)

   - Accept roll no. & name of book from user.
   - Check the number of days (from date of issue), if days are between 15 and 30, then fine amountwill be Rs 5 per day.
   - If no. of days>30, per day fine will be Rs 50 per day & for days less than 30, Rs. 5 per day.
   - After submitting the book, status will change from I to R.
   - If condition of fine is true, then details will be stored into fine table Write a PL/SQL block for using procedure created with above requirement.

5. Write a PL/SQL block of code using parameterized Cursor that will merge the data available in the newly created table N Roll Call with the data available in the table O_RollCall. If the data in the firsttable already exist in the second table then that data should be skipped.

   Database Trigger: Write a database trigger on Library table. The System should keep track of the records that are being updated or deleted. The old value of updated or deleted records should be added in Library_Audit table.

Group C- Database Programming Languages – No SQL

6. Mongo DB queries:Designand Develop Mango DB Queries usingCRUD operations.(use CRUD operations, SAVE Method and logical operators)
7. Mango DB – Aggregation and Indexing: Design and Develop Mango DB Queries using Aggregation and Indexing with suitable example.
8. Mango DB Map reduces operations: Implement Map reduces operation with suitable example using Mango DB

Group D- Mini Project: Database Project Life Cycle

9. Design and develop database application with following details:

   Requirement Gathering and Scope finalization Database Analysis and Design:

   - Design Entity Relationship Model, Relational Model, Database Normalization
   - Implementation :
   - Front End : Java/Perl/PHP/Python/Ruby/.net

- Backend : MYSQL/Oracle/ MongoDB
- Database Connectivity : ODBC/JDBC

Testing: Data Validation

Group of students should submit the Project Report which will consist of documentation related to different phases of Software Development Life Cycle: Title of the Project, Abstract, Introduction, scope, Requirements, Data Modeling features, Data Dictionary, Relational Database Design, Database Normalization, Graphical User Interface, Source Code, Testing document, Conclusion

Virtual LAB Links:

Link of the Virtual Lab: http://vlabs.iitb.ac.in/vlabs-dev/labs/dblab/index.php

The CO-PO mapping table

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

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
210658: Project Based Learning II)

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

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.

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

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

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%) Contest Participation/ publication (15%)
5.

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

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?
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@The CO-PO Mapping Matrix

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CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	3	-	-	-	-	-	-	-	-
CO4	-	-	-	-	2	-	-	-	-	-	-	-
CO5	-	-	-	-	-	3	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	-	-	-	2

Savitribai Phule Pune University
Second Year of Computer Science and Engineering (Data Science)
(2019 Course)
210659: Code of Conduct

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Tutorial: 01 Hours/Week	01[$]	Term work[$]: 25 Marks

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 engineer 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 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

Computers, Software, and Digital Information 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

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 copyright free 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%)

Recommended Assessment and Weightage Parameters:

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 Computer Science and Engineering (Data science) (2019 Course)
210660: 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
AC4-I	Water Management
AC4-II	Intellectual Property Rights and Patents
AC4-III	The Science of Happiness
AC4-IV	Stress Relief: Yoga and Meditation
AC4-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

AC4-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

AC4-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 partes 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

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CO1	-	-	-	-	-	-	-	1	-	-	-	1
CO2	-	-	-	-	-	-	-	2	-	-	-	1
CO3	-	-	-	-	-	-	-	1	-	-	-	1

AC4-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.

C.Compton, Edward Hoffman, "Positive Psychology: The Science of Happiness and Flourishing", William, Cengage Learning, 2012, ISBN10: 1111834121.

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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

AC4-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

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CO1	1	1	-	-	-	2	-	-	2	-	-	-
CO2	-	-	-	-	-	2	1	-	-	-	-	-
CO3	-	2	-	-	-	2	-	-	-	-	-	-
CO4	-	2	-	-	-	-	-	2	-	-	-	-

AC4-V: Foreign Language (Japanese) Module 2

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!!

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)

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CO1	-	-	-	-	-	-	-	-	1	3	1	1
CO2	-	-	-	-	1	-	-	-	-	3	1	1
CO3	-	-	-	-	1	-	-	-	-	3	2	2
CO4	-	-	-	-	-	-	-	-	-	1	-	1