

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



<http://unipune.ac.in>

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

(With effect from Academic Year 2021-22)

Table of Contents

Sr. No.	Title	Page Number
1.	<u>Program Outcomes</u>	3
2.	<u>Program Specific Outcomes</u>	3
3.	<u>Course Structure</u> (Course titles, scheme for teaching, credit, examination and marking)	4
4.	<u>General Guidelines</u>	6
5.	Course Contents (Semester III)	8 To 48
	210241: <u>Discrete Mathematics</u>	9
	210242: <u>Fundamentals of Data Structures</u>	12
	210243: <u>Object Oriented Programming (OOP)</u>	15
	210244: <u>Computer Graphics</u>	18
	217521: <u>Operating Systems</u>	21
	217522: <u>Data Structures Laboratory</u>	23
	217523: <u>OOP and Computer Graphics Laboratory</u>	28
	217524: <u>Operating Systems Laboratory</u>	32
	217525: <u>Business Communication Skills</u>	34
	217526: <u>Humanity and Social Science</u>	37
	217527: <u>Audit Course 3</u>	43
6.	Course Contents (Semester IV)	50 To 80
	217528: <u>Statistics</u>	50
	217529: <u>Internet of Things</u>	53
	210253: <u>Data Structures and Algorithms</u>	55
	210252: <u>Software Engineering</u>	58
	217530: <u>Management Information Systems</u>	61
	217531: <u>Internet of Things Laboratory</u>	64
	217532: <u>Data Structures and Algorithms Laboratory</u>	67
	217533: <u>Project Based Learning II</u>	71
	210234: <u>Code of Conduct</u>	76
	217535: <u>Audit Course 4</u>	81
7.	<u>Acknowledgement</u>	87
8.	<u>Task Force at Curriculum Design</u>	88

Savitribai Phule Pune University Bachelor of Computer Engineering		
Program Outcomes (POs)		
Learners are expected to know and be able to—		
PO1	Engineering knowledge	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems.
PO2	Problem analysis	Identify, formulate, review research literature and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and Engineering sciences.
PO3	Design / Development of Solutions	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations.
PO4	Conduct Investigations of Complex Problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern Tool Usage	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.
PO6	The Engineer and Society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practices.
PO7	Environment and Sustainability	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of Engineering practice.
PO9	Individual and Team Work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication Skills	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project Management and Finance	Demonstrate knowledge and understanding of Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments.
PO12	Life-long Learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
Program Specific Outcomes (PSO)		
A graduate of the Computer Engineering Program will demonstrate—		
PSO1	Professional Skills -The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, networking, artificial intelligence and data science for efficient design of computer-based systems of varying complexities.	
PSO2	Problem-Solving Skills - The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.	
PSO3	Successful Career and Entrepreneurship - The ability to employ modern computer languages, environments and platforms in creating innovative career paths to be an entrepreneur and to have a zest for higher studies.	

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

217526: Options for Audit Course 3

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

Savitribai Phule Pune University																											
Second Year of Artificial Intelligence and Data Science (2020 Course)																											
(With effect from Academic Year 2021-22)																											
Semester-IV																											
Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks							Credit Scheme															
		Lecture	Practical	Tutorial	Mid-Sem	End-Sem	Term	work	Practical	Oral	Total	Lecture	Practical	Tutorial	Total												
217528	<u>Statistics</u>	03	-	-	30	70	-	-	-	-	100	03	--	-	03												
217529	<u>Internet of Things</u>	03	-	-	30	70	-	-	-	-	100	03	-	-	03												
210252	<u>Data Structures and Algorithms</u>	03	-	-	30	70	-	-	-	-	100	03	-	-	03												
210253	<u>Software Engineering</u>	03	-	-	30	70	-	-	-	-	100	03	-	-	03												
217530	<u>Management Information System</u>	03	-	-	30	70	-	-	-	-	100	03	-	-	03												
217531	<u>Internet of Things Laboratory</u>	-	04	-	-	-	50	25	-	75	-	02	-	02	02												
217532	<u>Data Structures and Algorithms Laboratory</u>	-	04	-	-	-	25	25	-	50	-	02	-	02	02												
217533	<u>Project Based Learning II</u>	-	04	-	-	-	50	-	-	50	-	02	-	02	02												
217534	<u>Code of Conduct</u>	-	-	01	-	-	25	-	-	25	-	-	01	01	01												
217535	<u>Audit Course 4</u>	Grade																									
		Total	15	12	01	150	350	150	50	-	700	-	-	-	-												
		Total Credit																									
217535: Options for Audit Course 4																											
Audit Course Code	Audit Course Title																										
217535-I	Water Management																										
217535-II	Intellectual Property Rights and Patents																										
217535-III	The Science of Happiness																										
217535-IV	Stress Relief: Yoga and Meditation																										
217535-V	Foreign Language (one of Japanese/Spanish/French/German) Course contents for Japanese(Module 2) are provided. For other languages institute may design suitably.																										

General Guidelines

1. Every undergraduate program has its own objectives and educational outcomes. These objectives and outcomes are furnished by considering various aspects and impacts of the curriculum. The **Program Outcomes (POs)** are categorically mentioned at the beginning of the curriculum (ref: NBA Manual). There should always be a rationale and a goal behind the inclusion of a course in the curriculum. Course Outcomes though highly rely on the contents of the course; many-a-times are generic and bundled. The **Course Objectives, Course Outcomes** and **CO-PO mappings matrix** justifies the motives, accomplishment and prospect behind learning the course. The Course Objectives, and Course Outcomes are provided for reference and these are indicative only. The course instructor may modify them as per his or her perspective.
2. @:**CO and PO Mapping Matrix** (Course Outcomes and Program Outcomes)- The **expected** attainment mapping matrix at end of course contents, indicates the correlation levels of 3, 2, 1 and ‘-’. The notation of 3, 2 and 1 denotes substantially (high), moderately (medium) and slightly (low). The mark ‘-’ indicates that there is no correlation between the respective CO and PO. CO-PO Mapping Matrix values are provided for reference and these are indicative only. The course instructor may modify them as per his or her perspective.
3. #:**Elaborated examples/Case Studies**- For each course, contents are divided into six units-I, II, III, IV, V and VI. Elaborated examples/Case Studies are included at the end of each unit to explore how the learned topics apply to real world situations and need to be explored so as to assist students to increase their competencies, inculcating the specific skills, building the knowledge to be applicable in any given situation along with an articulation. One or two sample exemplars or case studies are included for each unit; instructor may extend the same with more. **Exemplar/Case Studies may be assigned as self-study by students and to be excluded from theory examinations.**
4. *:For each unit contents, the desired content attainment mapping is indicated with Course Outcome(s). Instructor may revise the same as per their viewpoint.
5. For laboratory courses, set of suggested assignments is provided for reference. Laboratory Instructors may design suitable set of assignments for respective course at their level. **Beyond curriculum assignments and mini-project may be included as a part of laboratory work.** The Inclusion of few optional assignments that are intricate and/or beyond the scope of curriculum will surely be the value addition for the students and it will satisfy the intellectuals within the group of the learners and will add to the perspective of the learners.
6. For each laboratory assignment, it is essential for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorial may be as per guidelines of authority.
7. For each course, irrespective of the examination head, the instructor should motivate students to read and publish articles, research papers related to recent development and invention in the field.
8. For laboratory, instructions have been included about the conduction and assessment of laboratory work. **These guidelines are to be strictly followed.** **Use of open source software is appreciated.**
9. **Term Work^[1]**—Term work is continuous assessment that evaluates a student's progress throughout the semester^[1]. Term work assessment criteria specify the standards that must be met and the evidence that will be gathered to demonstrate the achievement of course outcomes. Categorical assessment criteria for the term work should establish unambiguous standards of achievement for each course outcome. They should describe what the learner is expected to perform in the laboratories or on the fields to show that the course outcomes have been achieved. **It is recommended to conduct internal monthly practical examination as part of continuous assessment.**

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

10. **Laboratory Journal-** Program codes with sample output of all performed assignments are to be submitted as softcopy. Use of DVD or similar media containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Submission of journal/ term work in the form of softcopy is desirable and appreciated.
11. **Tutorial^[1]** - Tutorials can never be an individual course but an additional aid to the learners. Tutorials help the learners to inculcate the contents of the course with focused efforts on small group of the learners. Tutorial conduction should concentrate more on simplifying the intricacies converging to clear understanding and application. Assessment of tutorial work is to be done in a manner similar to assessment of term-work; do follow same guidelines.
12. **Audit Course^[1]** The student registered for audit course shall be awarded the grade AP/PP (Audit Course Pass) and the grade 'AP'/'PP' shall be included in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory performance and secured a passing grade in that audit course. No grade points are associated with this 'AP'/'PP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself.
13. \$:For courses 217529: Business Communication Skills, 217530: Humanity and Social Science and 217534: Code of Conduct, one credit can be earned by student if student successfully completes the Swayam course as listed in curriculum of respective course in this document.

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

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

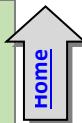
Note: For Examination rules, pattern and assessment please refer [\[1\]](#)

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

[2] <https://swayam.gov.in/about>

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

Semester III



Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
210241: Discrete Mathematics

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

Prerequisites: Basic Mathematics

Companion Course : ---

Course Objectives:

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

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

Course Outcomes:

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

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

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

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

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

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

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

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

Course Contents

Unit I	Set Theory and Logic	(07 Hours)
Introduction and significance of Discrete Mathematics, Sets – Naïve Set Theory (Cantorian Set Theory), Axiomatic Set Theory, Set Operations, Cardinality of set, Principle of inclusion and exclusion. Types of Sets – Bounded and Unbounded Sets, Diagonalization Argument, Countable and Uncountable Sets, Finite and Infinite Sets, Countably Infinite and Uncountably Infinite Sets, Power set, Propositional Logic - logic, Propositional Equivalences, Application of Propositional Logic- Translating English Sentences, Proof by Mathematical Induction and Strong Mathematical Induction.		
#Exemplar/Case Studies	Know about the great philosophers- Georg Cantor, Richard Dedekind and Aristotle	
*Mapping of Course Outcomes for Unit I	CO1, CO2, CO3	
Unit II	Relations and Functions	(07 Hours)



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

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

Unit III Counting Principles (07 Hours)

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

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

Unit IV Graph Theory (07 Hours)

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

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

Unit V Trees (07 Hours)

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

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

Unit VI Algebraic Structures and Coding Theory (07 Hours)

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

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

Learning Resources

Text Books:

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

Reference Books:

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw-Hill, ISBN 978-0-07-288008-3
2. Bernard Kolman, Robert C. Busby and Sharon Ross, "Discrete Mathematical Structures", Prentice-Hall of India /Pearson, ISBN: 0132078457, 9780132078450.
3. Narsingh Deo, "Graph with application to Engineering and Computer Science", Prentice Hall of India, 1990, 0 – 87692 – 145 – 4.
4. Eric Gossett, "Discrete Mathematical Structures with Proofs", Wiley India Ltd, ISBN:978-81-265-2758-8.
5. Sriram P.and Steven S., "Computational Discrete Mathematics", Cambridge University Press, ISBN 13: 978-0-521-73311-3.

e-Books:

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

MOOC/ Video Lectures available at:

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

@The CO-PO Mapping Matrix

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



Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
210242: Fundamentals of Data Structures

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

Prerequisite Courses: 110005: Programming and Problem Solving

Companion Course: 217526: Data Structures Laboratory

Course Objectives:

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

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

Course Outcomes:

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

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

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

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

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

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

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

Course Contents

Unit I	Introduction to Algorithm and Data Structures (07 Hours)
Introduction: From Problem to Program (Problem, Solution, Algorithm, Data Structure and Program). Data Structures: Data, Information, Knowledge, and Data structure, Abstract Data Types (ADT), Data Structure Classification (Linear and Non-linear, Static and Dynamic, Persistent and Ephemeral data structures).	
Algorithms: Problem Solving, Introduction to algorithm, Characteristics of algorithm, Algorithm design tools: Pseudo-code and flowchart. Complexity of algorithm: Space complexity, Time complexity, Asymptotic notation- Big-O, Theta and Omega, finding complexity using step count method, Analysis of programming constructs-Linear, Quadratic, Cubic, Logarithmic. Algorithmic Strategies: Introduction to algorithm design strategies- Divide and Conquer, and Greedy strategy.	
#Exemplar/Case Studies	Multiplication technique by the mathematician Carl Friedrich Gauss and Karatsuba algorithm for fast multiplication.
*Mapping of Course Outcomes for Unit I	CO1, CO2
Unit II	Linear Data Structure Using Sequential Organization (07 Hours)



Concept of Sequential Organization, Overview of Array, Array as an Abstract Data Type, Operations on Array, Merging of two arrays, Storage Representation and their Address Calculation: Row major and Column Major, Multidimensional Arrays: Two-dimensional arrays, n-dimensional arrays. Concept of Ordered List, **Single Variable Polynomial**: Representation using arrays, Polynomial as array of structure, Polynomial addition, Polynomial multiplication. **Sparse Matrix**: Sparse matrix representation using array, Sparse matrix addition, Transpose of sparse matrix- Simple and Fast Transpose, Time and Space tradeoff.

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

*Mapping of Course Outcomes for Unit II	CO1, CO2, CO3
--	---------------

Unit III **Searching and Sorting** **(07 Hours)**

Searching: Search Techniques-Sequential Search/Linear Search, Variant of Sequential Search-Sentinel Search, Binary Search, Fibonacci Search, and Indexed Sequential Search.

Sorting: Types of Sorting-Internal and External Sorting, General Sort Concepts-Sort Order, Stability, Efficiency, and Number of Passes, Comparison Based Sorting Methods-Bubble Sort, Insertion Sort, Selection Sort, Quick Sort, Shell Sort,

Non-comparison Based Sorting Methods-Radix Sort, Counting Sort, and Bucket Sort, Comparison of All Sorting Methods and their complexities

#Exemplar/Case Studies	Use of Fibonacci search in non-uniform access memory storage and in Optimization of Unimodal Functions. Timsort as a hybrid stable sorting algorithm
-------------------------------	--

*Mapping of Course Outcomes for Unit III	CO1, CO2, CO4
---	---------------

Unit IV **Linked List** **(07 Hours)**

Introduction to Static and Dynamic Memory Allocation,

Linked List: Introduction, of Linked Lists, Realization of linked list using dynamic memory management, operations, Linked List as ADT, **Types of Linked List:** singly linked, linear and Circular Linked Lists, Doubly Linked List, Doubly Circular Linked List, Primitive Operations on Linked List-Create, Traverse, Search, Insert, Delete, Sort, Concatenate. Polynomial Manipulations-Polynomial addition. Generalized Linked List (GLL) concept, Representation of Polynomial using GLL.

#Exemplar/Case Studies	Garbage Collection
-------------------------------	--------------------

*Mapping of Course Outcomes for Unit IV	CO1, CO2, CO3, CO5
--	--------------------

Unit V **Stack** **(07 Hours)**

Basic concept, stack Abstract Data Type, Representation of Stacks Using Sequential Organization, stack operations, Multiple Stacks,

Applications of Stack- Expression Evaluation and Conversion, Polish notation and expression conversion, Need for prefix and postfix expressions, Postfix expression evaluation, Linked Stack and Operations.

Recursion- concept, variants of recursion- direct, indirect, tail and tree, backtracking algorithmic strategy, use of stack in backtracking.

#Exemplar/Case Studies	Android- multiple tasks/multiple activities and back-stack, Tower of Hanoi, 4 Queens problem.
-------------------------------	---

*Mapping of Course Outcomes for Unit V	CO1, CO2, CO3, CO5, CO6
---	-------------------------

Unit VI **Queue** **(07 Hours)**

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

<u>#Exemplar/Case Studies</u>	Priority queue in bandwidth management
-------------------------------	--

<u>*Mapping of Course Outcomes for Unit VI</u>	CO1, CO2, CO3, CO5, CO6
--	-------------------------

Learning Resources

Text Books:

1. Horowitz, Sahani, Dinesh Mehata, "Fundamentals of Data Structures in C++", Galgotia Publisher, ISBN: 8175152788, 9788175152786.
2. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in Python", Wiley Publication, ISBN: 978-1-118-29027-9

Reference Books:

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

e-Books:

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

MOOC/ Video Lectures available at:

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

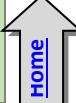
Other:

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

@The CO-PO Mapping Matrix

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





Savitribai Phule Pune University

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

210243: Object Oriented Programming(OOP)

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

Prerequisite Courses : 110005: Programming and Problem Solving

Companion Course : 217523: OOP and Computer Graphics Laboratory

Course Objectives:

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

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

Course Outcomes:

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

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

Course Contents

Unit I	Fundamentals of Object Oriented Programming	(07 Hours)
---------------	--	-------------------

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

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

#Exemplar/Case Studies	Story of C++ invention by Bjarne Stroustrup
-------------------------------	---

*Mapping of Course Outcomes for Unit I	CO1, CO5
---	----------

Unit II	Inheritance and Pointers	(07 Hours)
----------------	---------------------------------	-------------------

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

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

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

#Exemplar/Case Studies	Know about Firefox and Thunderbird as one of the popular softwares developed using C++
-------------------------------	--

*Mapping of Course Outcomes for Unit II	CO2, CO4
--	----------

Unit III Polymorphism (07 Hours)

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

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

#Exemplar/Case Studies	Study about use of C++ SDKs wrappers for Java and .Net.
-------------------------------	---

*Mapping of Course Outcomes for Unit III	CO2, CO3, CO4
---	---------------

Unit IV Files and Streams (07 Hours)

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

#Exemplar/Case Studies	Study features used for Microsoft Office, Internet Explorer and Visual Studio that are written in Visual C++
-------------------------------	--

*Mapping of Course Outcomes for Unit IV	CO2, CO4
--	----------

Unit V Exception Handling and Templates (07 Hours)

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

#Exemplar/Case Studies	Study about use of exception handling in Symbian Operating System (discontinued mobile operating system) that was developed using C++.
-------------------------------	--

*Mapping of Course Outcomes for Unit V	CO2, CO4, CO6
---	---------------

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

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

Algorithms- basic searching and sorting algorithms, min-max algorithm, set operations, heap sort,

Iterators- input, output, forward, bidirectional and random access. Object Oriented Programming – a road map to future

#Exemplar/Case Studies	Study MySQL open source C++ code available at GitHub.
-------------------------------	---

*Mapping of Course Outcomes for Unit VI	CO2, CO4, CO6
--	---------------

Learning Resources

Text Books:

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

Reference Books:

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

e-Books:

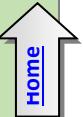
- <https://www.springer.com/gp/book/9781852334505>
- <https://www.ebookphp.com/object-oriented-programming-in-c-epub-pdf/>
- <https://www.springer.com/gp/book/9781447133780>

MOOC/ Video Lectures available at:

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

@The CO-PO Mapping Matrix

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



Savitribai Phule Pune University

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

210244: Computer Graphics

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

Prerequisite Course: Basic Mathematics

Companion Course: 217523: OOP and Computer Graphics Laboratory

Course Objectives:

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

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

Course Outcomes:

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

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

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

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

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

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

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

Course Contents

Unit I	Graphics Primitives and Scan Conversion Algorithms	(07 Hours)
--------	--	------------

Introduction, graphics primitives - pixel, resolution, aspect ratio, frame buffer. Display devices, applications of computer graphics.

Introduction to OpenGL - OpenGL architecture, primitives and attributes, simple modelling and rendering of two- and three-dimensional geometric objects, GLUT, interaction, events and call-backs picking. (**Simple Interaction with the Mouse and Keyboard**)

Scan conversion: Line drawing algorithms: Digital Differential Analyzer (DDA), Bresenham. Circle drawing algorithms: DDA, Bresenham, and Midpoint.

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

*Mapping of Course Outcomes for Unit I	CO1, CO2
--	----------

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

Polygons: Introduction to polygon, types: convex, concave and complex. Inside test.

Polygon Filling: flood fill, seed fill, scan line fill.

Windowing and clipping: viewing transformations, 2-D clipping: Cohen – Sutherland algorithm line Clipping algorithm, Sutherland Hodgeman Polygon clipping algorithm, Weiler Atherton Polygon Clipping algorithm.



#Exemplar/Case Studies	Study Guard-band clipping Technique and it's use in various rendering softwares, Use of 3D pipeline/ polygonal modelling and applications.	
*Mapping of Course Outcomes for Unit II	CO2, CO3	
Unit III	2D, 3D Transformations and Projections	(07 Hours)
2-D transformations: introduction, homogeneous coordinates, 2-D transformations - Translation, scaling, rotation and shear, rotation about an arbitrary point.		
3-D transformations: introduction, 3-D transformations - Translation, scaling, rotation and shear, rotation about an arbitrary axis.		
Projections : Parallel (Oblique: Cavalier, Cabinet and orthographic: isometric, diametric, trimetric) and Perspective (Vanishing Points – 1 point, 2 point and 3 point)		
#Exemplar/Case Studies	Study use of transformations and projections in education and training software.	
*Mapping of Course Outcomes for Unit III	CO2, CO4	
Unit IV	Light, Colour, Shading and Hidden Surfaces	(07 Hours)
Colour models: Properties of Light, CIE chromaticity Diagram, RGB, HSV, CMY.		
Illumination Models: Ambient Light, Diffuse reflection, Specular Reflection, and the Phong model, Combined diffuse and Specular reflections with multiple light sources, warn model,		
Shading Algorithms: Halftone, Gauraud and Phong Shading.		
Hidden Surfaces Introduction, Back face detection and removal, Algorithms: Depth buffer (z), Depth sorts (Painter), Area subdivision (Warnock)		
#Exemplar/Case Studies	Study any popular graphics designing software	
*Mapping of Course Outcomes for Unit IV	CO5	
Unit V	Curves and Fractals	(07 Hours)
Curves: Introduction, Interpolation and Approximation, Blending function, B-Spline curve, Bezier curve,		
Fractals: Introduction, Classification, Fractal generation: snowflake, Triadic curve, Hilbert curve, Applications.		
#Exemplar/Case Studies	Case study on measuring the length of coastline using fractals	
*Mapping of Course Outcomes for Unit V	CO2, CO6	
Unit VI	Introduction to Animation and Gaming	(07 Hours)
Segment: Introduction, Segment table, Segment creation, closing, deleting and renaming, Visibility.		
Animation: Introduction, Conventional and computer based animation, Design of animation sequences, Animation languages, Key- frame, Morphing, Motion specification.		
Gaming: Introduction, Gaming platform (NVIDIA, i8060), Advances in Gaming.		
#Exemplar/Case Studies	Study of any open source tools- Unity/Maya/Blender	
*Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		



Text Books:

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

Reference Books:

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

e-Books:

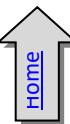
- <https://open.umn.edu/opentextbooks/textbooks/introduction-to-computer-graphics>
- <http://www2.cs.uidaho.edu/~jeffery/courses/324/lecture.html>

MOOC/ Video Lectures available at:

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

@The CO-PO Mapping Matrix

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



Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217521: Operating Systems

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

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

Companion Course, if any: 217524: Operating Systems Laboratory

Course Objectives:

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

Course Outcomes:

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

CO1: Enlist functions of OS and types of system calls

CO2: Apply process scheduling algorithms to solve a given problem

CO3: Illustrate deadlock prevention, avoidance and recovery

CO4: Explain memory management technique

CO5: Illustrate I/O and file management policies

CO6: Describe Linux process management

Course Contents

Unit I	Fundamental Concepts of Operating system	(06 Hours)
Operating system functions and characteristics, historical evolution of operating systems, issues in operating system design, User's view of the OS, Types of OS: Batch, time sharing, multiprogramming, distributed, network and real-time systems, Operating-System Services, Types of System Calls, System Programs. BASH Shell scripting: Basic shell commands, shell as a scripting language.		
#Exemplar/Case Studies		
Virtual Machines		
Mapping of Course Outcomes for Unit I	CO1	
Unit II	Process Management	(06 Hours)
Process concept, Process Control Block(PCB), Process Operations, Process Scheduling: Types of process schedulers, Types of scheduling: Preemptive, Non preemptive. Scheduling algorithms: FCFS, SJF, RR, Priority, Inter process Communication(IPC). Threads: multithreaded model, implicit threads, threading issues		
#Exemplar/Case Studies		
Thread programming Using Pthreads		
Mapping of Course Outcomes for Unit II	CO2	
Unit III	Process Coordination	(08 Hours)
Synchronization: Principles of Concurrency, Requirements for Mutual Exclusion, Mutual Exclusion: Hardware Support, Operating System Support (Semaphores and Mutex), Programming Language Support (Monitors).Classical synchronization problems:Readers/Writers Problem, Producer and Consumer problem, Inter-process communication (Pipes, shared memory: system V)		
Deadlock: Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock		
#Exemplar/Case Studies		
Process coordination in Unix operating system		
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Memory Management	(06 Hours)

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

#Exemplar/Case Studies	Memory Management in Unix operating system
------------------------	--

Mapping of Course Outcomes for Unit IV	CO4
--	-----

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

I/O Management: I/O Devices, Organization of I/O function, I/O Buffering, Disk SchedulingDisk Scheduling policies like FIFO, LIFO, STTF, SCAN, C-SCAN.

File Management: Concept, Access methods, Directory Structure, Protection, File System implementation, Directory Implementation, Allocation methods, Free Space management.

#Exemplar/Case Studies	I/OManagement in Unix operating system
------------------------	--

Mapping of Course Outcomes for Unit V	CO5
---------------------------------------	-----

Unit VI Linux (06 Hours)

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

#Exemplar/Case Studies	Ubuntu design principles
------------------------	--------------------------

Mapping of Course Outcomes for Unit VI	CO6
--	-----

Learning Resources

Text Books:

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

Reference Books:

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

e-Books:

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

MOOC Courses:

1. <https://nptel.ac.in/courses/106/105/106105214/>
2. <https://nptel.ac.in/courses/106/106/106106144/>

@The CO-PO mapping table

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



Savitribai Phule Pune University

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

217522: Data Structures Laboratory

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

Companion Course: 210242: Fundamental of Data Structures

Course Objectives:

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

Course Outcomes:

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

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

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

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

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

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and **handwritten write-up** of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. **Program codes with sample output of all performed assignments are to be submitted as softcopy.**

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

Guidelines for Laboratory / Term Work Assessment

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

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of Hungarian notation, proper indentation and comments. Use of open source software is to be encouraged. In addition to these, instructor may assign one real life application in the form of a mini-project based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

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



Group A and B assignments should be implemented in Python without using built-in methods for major functionality of assignment. Use List data structure of Python as array. Group C, D and E assignments should be implemented in C++ language.

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

Programming tools recommended: - Open Source Python, Programming tool like Jupyter Notebook, Pycharm, Spyder, G++/GCC.

Guidelines for Practical Examination

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

Virtual Laboratory:

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

Suggested List of Laboratory Experiments/Assignments

Sr. No	Group A
1	<p>In second year computer engineering class, group A student's play cricket, group B students play badminton and group C students play football.</p> <p>Write a Python program using functions to compute following: -</p> <ol style="list-style-type: none"> List of students who play both cricket and badminton List of students who play either cricket or badminton but not both Number of students who play neither cricket nor badminton Number of students who play cricket and football but not badminton. <p>(Note- While realizing the group, duplicate entries should be avoided, Do not use SET built-in functions)</p>
2	<p>Write a Python program to store marks scored in subject "Fundamental of Data Structure" by N students in the class. Write functions to compute following:</p> <ol style="list-style-type: none"> The average score of class Highest score and lowest score of class Count of students who were absent for the test Display mark with highest frequency
3	<p>Write a Python program for department library which has N books, write functions for following:</p> <ol style="list-style-type: none"> Delete the duplicate entries Display books in ascending order based on cost of books Count number of books with cost more than 500. Copy books in a new list which has cost less than 500.
4	<p>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.</p> <p>Suppose the following input is supplied to the program: D 300, D 300 , W 200, D 100 Then, the output should be: 500</p>
5	<p>Write a Python program to compute following operations on String:</p> <ol style="list-style-type: none"> To display word with the longest length To determines the frequency of occurrence of particular character in the string To check whether given string is palindrome or not To display index of first appearance of the substring To count the occurrences of each word in a given string



6	It is decided that weekly greetings are to be furnished to wish the students having their birthdays in that week. The consolidated sorted list with desired categorical information is to be provided to the authority. Write a Python program to store students PRNs with date and month of birth. Let List_A and List_B be the two list for two SE Computer divisions. Lists are sorted on date and month. Merge these two lists into third list “List_SE_Comp_DOB” resulting in sorted information about Date of Birth of SE Computer students																									
7	Write a Python Program for magic square. A magic square is an $n \times n$ matrix of the integers 1 to n^2 such that the sum of each row, column, and diagonal is the same. The figure given below is an example of magic square for case $n=5$. In this example, the common sum is 65.																									
	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>15</td><td>8</td><td>1</td><td>24</td><td>17</td></tr> <tr><td>16</td><td>14</td><td>7</td><td>5</td><td>23</td></tr> <tr><td>22</td><td>20</td><td>13</td><td>6</td><td>4</td></tr> <tr><td>3</td><td>21</td><td>19</td><td>12</td><td>10</td></tr> <tr><td>9</td><td>2</td><td>25</td><td>18</td><td>11</td></tr> </table>	15	8	1	24	17	16	14	7	5	23	22	20	13	6	4	3	21	19	12	10	9	2	25	18	11
15	8	1	24	17																						
16	14	7	5	23																						
22	20	13	6	4																						
3	21	19	12	10																						
9	2	25	18	11																						
8	Write a Python program that determines the location of a saddle point of matrix if one exists. An $m \times n$ matrix is said to have a saddle point if some entry $a[i][j]$ is the smallest value in row i and the largest value in j .																									
9	Write a Python program to compute following computation on matrix: a) Addition of two matrices B) Subtraction of two matrices c) Multiplication of two matrices d) Transpose of a matrix																									
10	Write a Python program for sparse matrix realization and operations on it- Transpose, Fast Transpose and addition of two matrices																									
	Group B																									
11	a) Write a Python program to store roll numbers of student in array who attended training program in random order. Write function for searching whether particular student attended training program or not, using Linear search and Sentinel search. b) Write a Python program to store roll numbers of student array who attended training program in sorted order. Write function for searching whether particular student attended training program or not, using Binary search and Fibonacci search																									
12	a) Write a Python program to store names and mobile numbers of your friends in sorted order on names. Search your friend from list using binary search (recursive and non-recursive). Insert friend if not present in phonebook b) Write a Python program to store names and mobile numbers of your friends in sorted order on names. Search your friend from list using Fibonacci search. Insert friend if not present in phonebook.																									
13	Write a Python program to maintain club members, sort on roll numbers in ascending order. Write function “Ternary_Search” to search whether particular student is member of club or not. Ternary search is modified binary search that divides array into 3 halves instead of two.																									
14	Write a Python program to store first year percentage of students in array. Write function for sorting array of floating point numbers in ascending order using a) Selection Sort b) Bubble sort and display top five scores.																									
15	Write a Python program to store second year percentage of students in array. Write function for sorting array of floating point numbers in ascending order using a) Insertion sort b) Shell Sort and display top five scores																									
16	Write a Python program to store first year percentage of students in array. Write function for sorting array of floating point numbers in ascending order using quick sort and display top five scores.																									
17	Write a Python program to store 12 th class percentage of students in array. Write function for sorting array of floating point numbers in ascending order using bucket sort and display top five scores.																									

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



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

@The CO-PO Mapping Matrix

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO12
CO1	1	1	2	1	-	-	-	-	-	-	-	-
CO2	2	2	2	1	-	-	-	-	-	-	-	-
CO3	-	2	1	1	-	-	-	-	-	-	-	-
CO4	1	2	2	1	-	-	-	-	-	-	-	-



Savitribai Phule Pune University

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

217523: OOP and Computer Graphics Laboratory

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

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

Course Objectives:

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

Course Outcomes:

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

- CO1:** Understand and apply the concepts like inheritance, polymorphism, exception handling and generic structures for implementing reusable programming codes.
- CO2:** Analyze the concept of file and apply it while storing and retrieving the data from secondary storages.
- CO3:** Analyze and apply computer graphics algorithms for line-circle drawing, scan conversion and filling with the help of object oriented programming concepts.
- CO4:** Understand the concept of windowing and clipping and apply various algorithms to fill and clip polygons.
- CO5:** Apply logic to implement, curves, fractals, animation and gaming programs.

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software and Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments are to be submitted as softcopy. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal must be avoided. Use of DVD containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory.

Guidelines for Laboratory /Term Work Assessment

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

Guidelines for Practical Examination

Problem statements must be decided by the internal examiner in consultation with the external examiner. During practical assessment, maximum weightage should be given to satisfactory implementation of the problem statement. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals, effective and efficient implementation. The questions asked will in no way be the deciding factor for passing the students. This will encourage, transparent evaluation and fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising start of student's academics.

Guidelines for Laboratory Conduction

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

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

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

Virtual Laboratory:

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

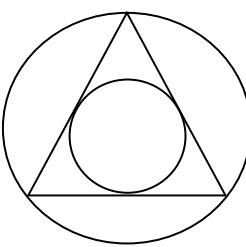
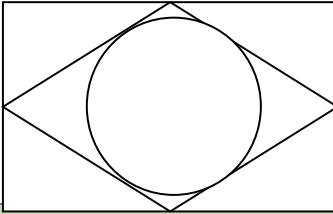
Part I : Object Oriented Programming

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

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



Part II : Computer Graphics

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

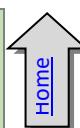
7. a) Write a C++ program to control a ball using arrow keys. Apply the concept of polymorphism.
OR
 b) Write a C++ program to implement bouncing ball using sine wave form. Apply the concept of polymorphism.
OR
 c) Write C++ program to draw man walking in the rain with an umbrella. Apply the concept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

Mini- Project

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

[@The CO-PO Mapping Matrix](#)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO12
CO1	-	1	2	1	-	-	-	-	-	-	-	-
CO2	-	1	2	1	-	-	-	-	-	-	-	-
CO3	2	1	1	-	-	-	-	-	-	-	-	-
CO4	1	2	2	1	-	-	-	-	-	-	-	-
CO5	-	2	2	1	-	-	-	-	-	-	-	-



Savitribai Phule Pune University

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

217524: Operating Systems Laboratory

Teaching Scheme:	Credit	Examination Scheme:
Practical: 02 Hours/Week	01	Term Work (TW): 25 Marks

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

Companion Course: 217525: Operating Systems

Course Objectives:

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

Course Outcomes:

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

- CO1:** Choose the best CPU scheduling algorithm for a given problem instance
CO2: Demonstrate interprocess communication
CO3: Apply deadlock avoidance algorithm
CO4: Compare performance of page replacement algorithms
CO5: Demonstrate the fundamental UNIX commands & system calls

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

List of Assignments

Group A

1. Given the list of processes, their CPU burst times. Display/print the Gantt chart for FCFS , SJF , Priority and Round Robin scheduling algorithm. Compute and print the average waiting time and average turnaround time
2. Implement producer-consumer problem with counting semaphores and mutex
3. Demonstrate Reader-Writer problem with reader priority or writer
4. Write a program to implement the Bankers Algorithm.
5. Write a program to implement page Replacement strategies (FIFO, LRU,Optimal)
6. Write a Program to implement paging simulation using Least Recently Used (LRU) and Optimal algorithm

Group B

1. Implement UNIX system calls like ps, fork, join, exec family, and wait for process management (use shell script/ Java/ C programming)Shell programming
2. Write a program to implement an address book with options given below: a) Create address book. b) View address book. c) Insert a record. d) Delete a record. e) Modify a record. f) Exit
3. Create a shell program to do mathematical operations.
4. Create a shell program to find string in a file using grep system call.

Group C

1. Inter process communication in Linux using Pipes

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

2. Inter process communication in Linux using FIFO

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

Learning Resources

Text Books:

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

Reference Books:

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

e-Books:

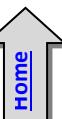
1. https://tecmint.tradepub.com/free/w_wile48/prgm.cgi?a=1
2. https://tecmint.tradepub.com/free/w_pack42/prgm.cgi?a=1
3. https://repository.dinus.ac.id/docs/ajar/Operating_System.pdf

MOOC Courses:

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

@The CO-PO mapping table

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



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

Teaching Scheme Practical: 02 Hours/Week	Credit Scheme 01^{\$}	Examination Scheme and Marks Term Work^{\$}: 25 Marks
--	---	---

Course Objectives:

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

Course Outcomes:

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

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

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal and Term Work Assessment

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

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

Recommended Assessment and Weightage Parameters:

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

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

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

Guidelines for Laboratory Conduction

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

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

MOOC at Swayam:

https://swayam.gov.in/nd2_imb19_mg14/preview

Virtual Laboratory:

- <https://ve-iitg.vlabs.ac.in/>

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

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University

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

217526: Humanity and Social Science

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

Course Objectives:

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

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

Course Outcomes:

On completion of the course, learner will be—

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

CO2: Aware about their responsibilities towards society.

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

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

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

Course Contents

Preamble:

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

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

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

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

MOOC/ Video Lectures available at\$:

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

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

Change of Mindset

- Since the course deviates from technical subjects, students will have to be counseled into the

importance of social sciences

- A background understanding of the importance of this course in their professional and personal life will have to be enumerated to the students
- Teachers will have to rationalize the course outcomes to get the students invested in the activities being conducted

Designing of Course

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

Basic function of the tutor

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

Grouping

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

Assessment of Learning

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

Tutorial Conduction and Term Work guidelines

Interactive Sessions to be conducted during Tutorial (in classroom)

1. PREPARED SPEECH ON CURRENT AFFAIRS
 - a. Purpose – Get students to stay abreast and invested in national current affairs
 - b. Method – Each student has to read an editorial from any national paper (English), find out more information on the topic and present it to the class; ending the session with his/her opinion on the matter
 - c. Outcome – Awareness of national state of affairs. Improve on oratory skills. Instil the thinking and contemplative skills and form non-judgmental opinions about an issue
2. UNDERSTANDING INDIA'S CULTURAL DIVERSITY
 - a. Purpose – Expose students to the intricacies of Indian cultural across various states
 - b. Method – Each student (or a small group of students in case the number of students is large) has to pick a state and come to the tutorial session prepared with a PPT that will showcase the demographic, sociographic and cultural information of that state
 - c. Outcome – Information about the beauty of Indian cultural diversity. Enhance exploratory skill, communication skills and learn to present using technological tools.

3. WRITING AN ARTICLE ON ANY SOCIAL ISSUE

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

4. GROUP DISCUSSION ON COMMUNAL TOPIC

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

5. QUIZ ON SOCIAL BEHAVIOR

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

6. SCREEN A MOVIE (FOCUS ON POSITIVITY AND POWER OF THE MIND)

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

7. QUIZ ON SOCIAL BEHAVIOR

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

8. SCREEN A MOVIE (FOCUS ON POSITIVITY AND POWER OF THE MIND)

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

9. DEBATE ON A TOPIC FROM SOCIAL SCIENCES

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

Interactive Activities to be conducted during Tutorial (Outside Classroom)

1. WASTE MANAGEMENT and CLEAN CAMPUS

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

2. MAKING A VIDEO ON SOCIAL WASTAGES.

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

3. RELAY MARATHON (3 – 5 kms)

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

4. TREE PLANTATION ON CAMPUS

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

5. VISIT TO AN OLD AGE HOME / ORPHANAGE

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

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

6. STREET PLAY ACTIVITY

- Purpose: Create awareness in themselves as well as people in the community on various social evils that need to be eradicated
- 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.
- 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

- 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.
- 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.
- Outcome: Appreciation and respect towards the responsibility of teaching. They will learn to be accountable as social contributors and bring about some change in the lives of the young students they mentor as Buddies or Big Brother.

Term Work Assessment Guidelines

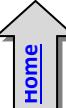
Students must submit the report of all conducted activities conducted during Tutorial (Outside Classroom) of at least 04 activities (out of 07 activities) from group (of 02-03) students.

The brief guidelines for report preparations are as follows:

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

Recommended Assessment and Weightage Parameters:

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



Learning Resources

Books:

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

e-Books:

- <https://www.moteoo.org/en/products/social-science-and-humanities-student-book-english>
- <https://www.springeropen.com/books>
(SpringerOpen open access books; download them free of charge from SpringerLink)
- <https://muse.jhu.edu/article/541846/pdf>

(This content has been declared free to read by the publisher during the COVID-19)

@The CO-PO Mapping Matrix

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

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

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

Criteria:

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

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

- | | |
|---|---|
| <ul style="list-style-type: none"> • Lectures/ Guest Lectures • Visits (Social/Field) and reports • Demonstrations | <ul style="list-style-type: none"> • Surveys • Mini-Project • Hands on experience on focused topic |
|---|---|

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

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

Audit Course 3 Options

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

Note: It is permitted to opt one of the audit courses listed at SPPU website too, if not opted earlier.

<http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202017/Forms/AllItems.aspx>

http://www.unipune.ac.in/university_files/syllabi.htm

Savitribai Phule Pune University

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

217527-I: Green Construction and Design

Prerequisites: General awareness of environment and eco system.

Course Objectives:

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

Course Outcomes:

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

CO1: Understand the importance of environment friendly society.

CO2: Apply primary measures to reduce carbon emissions from their surroundings.

CO3: Learn role of IT solutions in design of green buildings.

CO4: Understand the use of software systems to complete statutory compliances involved in the design of a new home or office building through green construction.

Course Contents

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

Team Projects:

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

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

References :

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

IGBC Green New Buildings Rating System, Version 3.0, Abridged Reference Guide September 2014.

Available:[https://igbc.in/igbc/html_pdfs/abridged/IGBC%20Green%20New%20Buildings%20Rating%20System%20\(Version%203.0\).pdf](https://igbc.in/igbc/html_pdfs/abridged/IGBC%20Green%20New%20Buildings%20Rating%20System%20(Version%203.0).pdf)

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO 11	PO 12
CO1	-	-	2	-	-	3	3	-	-	-	-	-
CO2	-	-	2	-	-	3	3	-	-	-	-	-
CO3	-	-	-	-	3	-	2	-	-	-	-	-
CO4	-	-	1	-	3	-	2	-	-	-	-	-

Savitribai Phule Pune University

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

Awareness about basic terms in Social Science and Governance

Course Objectives:

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

Course Outcomes:

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

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

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

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

CO4: Demonstrate basic features of Indian Constitution.

Course Contents

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

Activities:

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

References:

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

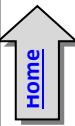
@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	2	-	-	-	-
CO2	-	-	-	-	-	-	-	3	2	-	-	-
CO3	-	-	-	-	-	-	-	2	2	-	-	-
CO4	-	-	-	-	-	-	-	1	1	-	-	-

Savitribai Phule Pune University

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

217527-III: Environmental Studies



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

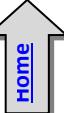
@The CO-PO Mapping Matrix

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	-	-	-	-	-

Savitribai Phule Pune University

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

217527-IV: Smart Cities



We breathe in a world defined by urbanization and digital ubiquity, where mobile broadband connections outnumber fixed ones, machines dominate a new "internet of things," and more people live in cities than in the countryside. This course enables us to take a broad historical look at the forces that have shaped the planning and design of cities and information technologies from the rise

of the great industrial cities of the nineteenth century to the present. This course considers the motivations, aspirations, and shortcomings of them all while offering a new civics to guide our efforts as we build the future together, one click at a time.

Course Objectives

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

Course Outcomes

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

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

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

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

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

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

Course Contents

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

References:

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

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO8	PO 9	PO10	PO11	PO12
CO1	-	2	2	-	-	2	2	1	-	-	-	-
CO2	1	2	1	-	-	1	1	-	-	-	-	-
CO3	2	1	3	3	2	-	1	-	1	1	1	
CO4	-	3	2	-	-	-	-	-	-	-	1	2

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

About course:

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

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

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

Course Objectives:

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

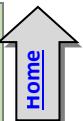
Reference:

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	P OI2
CO1	-	-	-	-	-	-	-	-	1	3	1	1
CO2	-	-	-	-	1	-	-	-	-	3	1	1
CO3	-	-	-	-	1	-	-	-	-	3	2	2
CO4	-	-	-	-	-	-	-	-	-	1	-	1

Semester IV



Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217528 : Statistics

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

Prerequisite Courses: 210241: Discrete Mathematics

Companion Course:

Course Objectives:

- Demonstrate knowledge of probability and the standard statistical distributions.

Course Outcomes:

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

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

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

CO3: Use distribution functions for random variables

CO4: Distinguish between correlation coefficient and regression

CO5: Understand tests for hypothesis and its significance

Course Contents

Unit I	Introduction To Statistics And Sampling Theory	(6 Hours)
Statistics: Introduction, Origin and Development of Statistics, Definition, Importance and Scope, Limitations, Distrust of Statistics		
Population and Sample: Sampling –Introduction, Types of Sampling, Purposive Sampling, Random Sampling, Simple Sampling, Stratified Sampling, Parameter and Statistic, Sampling Distribution, Statistical Inference, Sampling With and Without Replacement, Random Samples: Random Numbers, Population Parameters, Sample Statistics, Sampling Distributions		
#Exemplar/Case Studies.		
Mapping of Course Outcomes for Unit I	CO1	
Unit II	Descriptive Statistics: Measures Of Central Tendency	(6 Hours)
Frequency Distributions and Measures of central Tendency: Frequency Distribution, Continuous Frequency Distribution, Graphic Representation of a Frequency Distribution, Histogram, Frequency Polygon, Averages or Measures of Central Tendency or Measures of Location, Requisites for an Ideal Measure of Central Tendency, Arithmetic Mean, Properties of Arithmetic Mean, Merits and Demerits of Arithmetic Mean, Weighted Mean, Median, Merits and Demerits of Median, Mode, Merits and Demerits of Mode, Geometric Mean, Merits and Demerits of Geometric Mean, Harmonic Mean, Merits and Demerits of Harmonic Mean, Selection of an Average		
#Exemplar/Case Studies.		
Mapping of Course Outcomes for Unit II	CO1	
Unit III	Descriptive Statistics: Measures of Dispersion	(6 Hours)
Measures of Dispersion, Skewness and Kurtosis: Dispersion, Characteristics for an Ideal Measure of Dispersion, Measures of Dispersion, Range, Quartile Deviation, Mean Deviation, Standard Deviation and Root Mean Square Deviation, Coefficient of Dispersion, Coefficient of Variation, Skewness, Kurtosis		

Correlation and Regression : Bivariate Distribution, Scatter diagrams, Correlation, Karl Pearson's coefficient of correlation, Rank correlation, Regression, Lines of Regression, Regression Coefficients, Binomial and multinomial distributions, Poisson distribution, Uniform distribution, Exponential distribution, Gaussian distribution, Log-normal distribution, Chi-square distribution

#Exemplar/Case Studies.	Create measures of dispersion for a real life example dataset like students dataset , iris detection etc
-------------------------	--

Mapping of Course Outcomes for Unit III	CO2
---	-----

Unit IV	Random Variables And Probability Distributions	(8 Hours)
----------------	---	------------------

Random Variables and Distribution Functions:

Random Variable, Distribution Function, Properties of Distribution Function, Discrete Random Variable, Probability Mass Function, Discrete Distribution Function, Continuous Random Variable, Probability Density Function

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

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

Mapping of Course Outcomes for Unit IV	CO3
--	-----

Unit V	Inferential Statistics: Hypothesis	(6 Hours)
---------------	---	------------------

Statistical Inference - Testing of Hypothesis, Non-parametric Methods and Sequential Analysis:

Introduction, Statistical Hypothesis (Simple and-Composite), Test of a Statistical Hypothesis, Null Hypothesis, Alternative Hypothesis, Critical Region, Two Types of Errors, level of Significance, Power of the Test

#Exemplar/Case Studies.	Hypothesis Testing for examples like: Dieters lose more fat than the exercisers, New medicine testing
-------------------------	---

Mapping of Course Outcomes for Unit V	CO4
---------------------------------------	-----

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

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

#Exemplar/Case Studies.	Study hypothesis testing for any examples like To determine whether the female proportion of the adult population is high or any similar example
-------------------------	--

Mapping of Course Outcomes for Unit VI	CO5
--	-----

Learning Resources

Text Books:

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

Reference Books:

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

e-Books:

1. <https://www.itl.nist.gov/div898/handbook/>
2. <https://web.stanford.edu/~hastie/ElemStatLearn/index.html>

MOOC Courses:

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

@The CO-PO mapping table

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

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

Teaching Scheme:	Credit	Examination Scheme:
Lecture: 03 Hours/Week	03	Mid_Semester(TH): 30 Marks End_Semester(TH): 70 Marks
Prerequisite Courses: 110005: Programming and Problem Solving		
Companion Course: 217531: Internet of Things Laboratory		
Course Objectives:		
<ul style="list-style-type: none"> ● Understand the Basic Digital Electronics and microprocessors. ● To introduce students with the architecture and operation of typical microprocessors and microcontrollers and its interfacing ● Understand the definition and significance of the Internet of Things. ● Interface and deploy analog and digital sensors. ● To learn real world application scenarios of IoT along with its societal and economic impact using case studies. 		

Course Outcomes:		
On completion of the course, learner will be able to—		
CO1: Have a thorough understanding of the structure, function and characteristics of computer systems and Understand the structure of various number systems and its application in digital design.		
CO2: Develop the skill set to build IoT systems and sensor interfacing.		
CO3: Explain the concept of Internet of Things and identify the technologies that make up the internet of things		
CO4: Analyze trade-offs in interconnected wireless embedded device networks. Select Appropriate Protocols for IoT Solutions		
CO5: Design a simple IoT system comprising sensors by analyzing the requirements of IoT Application		
CO6: Identify the Application of IoT in automation of Commercial and Real World examples		

Course Contents

Unit I	Fundamentals of Computer Organization & Digital Electronics	(09 Hours)
Basic Organization of Computers, Classification Micro, Mini, Mainframe and Super Computer. System Bus and Interconnection, PCI, Computer Function, I-Cycle, Interrupt and Class of Interrupts.		
Number systems, Decimal Number system, Binary number system, Octal & Hexadecimal number system, 1's & 2's complement, Binary Fixed Point Representation.		
#Exemplar/Case Studies		
Mapping of Course Outcomes for Unit I	Various sensors and its internal operation	
Unit II	Communication Interface	(06 Hours)
Basic Peripherals & their interfacing with 8086/8088, Semiconductor Memory Interfacing-Dynamic RAM Interfacing-Interfacing I/O ports-PIO-8255, Modes of operation-interfacing Analog-Digital Data converter-stepper motor interfacing.		
#Exemplar/Case Studies		
Mapping of Course Outcomes for Unit II	CO2	
Unit III	Introduction & IOT Technologies behind smart and intelligent devices	(09 Hours)
IoT Concepts, Introduction to IOT Communications, Telemetry vs IOT, Applications of IOT Communications, People, Processes and Devices.		
Automation, asset management, telemetry, transportation, telematics. Telemetry and Telemetric; Report		

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

#Exemplar/Case Studies	Big Data, Cloud Computing	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	IOT Systems, Network and Protocols	(07 Hours)

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

#Exemplar/Case Studies	RFID, Industry 4.0- IOT	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	IOT Design and System Engineering	(06 Hours)

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

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

Unit VI	IOT Applications	(07 Hours)
IOT Verticals; IOT Hosted Services; IOT Application development, IOT Connectivity; IOT Software providers; Review of various IoT application domains including agriculture, healthcare, manufacturing, device management, and vehicle to vehicle communication and wearable computing devices.		
#Exemplar/Case Studies	Rural Development using IOT	

Mapping of Course Outcomes for Unit VI	CO6
---	-----

Learning Resources

Text Books:

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

Reference Books:

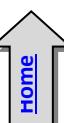
1. David Hanes, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, ISBN-13: 978-1-58714-456-1, ISBN-10: 1-58714-456-5, 2017
2. Olivier Hersistent, Omar Elloumi and David Boswarthick, "The Internet of Things: Applications to the Smart Grid and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

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

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

@The CO-PO mapping table

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



Savitribai Phule Pune University

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

210252: Data Structures and Algorithms

Teaching Scheme:	Credit	Examination Scheme:
Lecture: 03 Hours/Week	03	Mid_Semester(TH): 30 Marks End_Semester(TH): 70 Marks
Prerequisite Courses:		110005: Programming and Problem Solving 210242: Fundamentals of Data Structures
Companion Course:		217532: Data Structures and Algorithms Laboratory
<p>Course Objectives:</p> <p>The course is intended to provide the foundations of the practical implementation and usage of Data Structures and Algorithms to ensure that the learner evolves into a competent programmer capable of designing and analyzing implementations of data structures and algorithms for different kinds of problems.</p> <ul style="list-style-type: none"> • To develop a logic for graphical modeling of the real life problems. • To suggest appropriate data structure and algorithm for graphical solutions of the problems. • To understand advanced data structures to solve complex problems in various domains. • To operate on the various structured data • To build the logic to use appropriate data structure in logical and computational solutions. • To understand various algorithmic strategies to approach the problem solution. 		
<p>Course Outcomes:</p> <p>On completion of the course, learner will be able to–</p> <p>CO1: Identify and articulate the complexity goals and benefits of a good hashing scheme for real-world applications.</p> <p>CO2: Apply non-linear data structures for solving problems of various domain.</p> <p>CO3: Design and specify the operations of a nonlinear-based abstract data type and implement them in a high-level programming language.</p> <p>CO4: Analyze the algorithmic solutions for resource requirements and optimization</p> <p>CO5: Use efficient indexing methods and multiway search techniques to store and maintain data.</p> <p>CO6: Use appropriate modern tools to understand and analyze the functionalities confined to the secondary storage.</p>		
Course Contents		
Unit I	Hashing	(07 Hours)
<p>Hash Table- Concepts-hash table, hash function, basic operations, bucket, collision, probe, synonym, overflow, open hashing, closed hashing, perfect hash function, load density, full table, load factor, rehashing, issues in hashing, hash functions- properties of good hash function, division, multiplication, extraction, mid-square, folding and universal, Collision resolution strategies- open addressing and chaining, Hash table overflow- open addressing and chaining, extendible hashing, closed addressing and separate chaining.</p> <p>Skip List- representation, searching and operations- insertion, removal</p>		
#Exemplar/Case Studies		Book Call Number and Dictionary
Mapping of Course Outcomes for Unit I		CO1, CO4
Unit II	Trees	(08 Hours)
<p>Tree- basic terminology, General tree and its representation, representation using sequential and linked organization, Binary tree- properties, converting tree to binary tree, binary tree traversals(recursive and non-recursive)- inorder, preorder, post order, depth first and breadth first, Operations on binary tree. Huffman Tree (Concept and Use), Binary Search Tree (BST), BST operations, Threaded binary search tree- concepts, threading, insertion and deletion of nodes in in-order threaded binary search tree, in order traversal of in-order threaded binary search tree.</p>		

#Exemplar/Case Studies	Use of binary tree in expression tree-evaluation and Huffman's coding			
Mapping of Course Outcomes for Unit II	CO2, CO3, CO4			
Unit III	Graphs	(07 Hours)		
Basic Concepts, Storage representation, Adjacency matrix, adjacency list, adjacency multi list, inverse adjacency list. Traversals -depth first and breadth first, Minimum spanning Tree, Greedy algorithms for computing minimum spanning tree- Prims and Kruskal Algorithms, Dijktra's Single source shortest path, All pairs shortest paths- Flyod-Warshall Algorithm Topological ordering.				
#Exemplar/Case Studies	Data structure used in Webgraph and Google map			
Mapping of Course Outcomes for Unit III	CO2, CO3, CO4			
Unit IV	Search Trees	(08 Hours)		
Symbol Table-Representation of Symbol Tables- Static tree table and Dynamic tree table, Weight balanced tree - Optimal Binary Search Tree (OBST), OBST as an example of Dynamic Programming, Height Balanced Tree- AVL tree. Red-Black Tree, AA tree, K-dimensional tree, Splay Tree.				
#Exemplar/Case Studies	Keyword search in a document using OBST			
Mapping of Course Outcomes for Unit IV	CO2, CO3, CO5			
Unit V	Indexing and Multiway Trees	(07 Hours)		
Indexing and Multiway Trees - Indexing, indexing techniques-primary, secondary, dense, sparse, Multiway search trees, B-Tree- insertion, deletion, B+Tree - insertion, deletion, use of B+ tree in Indexing, Trie Tree.				
#Exemplar/Case Studies	Heap as a Priority Queue			
Mapping of Course Outcomes for Unit V	CO2, CO3, CO5			
Unit VI	File Organization	(07 Hours)		
Files : concept, need, primitive operations. Sequential file organization - concept and primitive operations, Direct Access File - Concepts and Primitive operations, Indexed sequential file organization -concept, types of indices, structure of index sequential file, Linked Organization -multi list files, coral rings, inverted files and cellular partitions.				
#Exemplar/Case Studies	External Sort - Consequential processing and merging two lists, multiway merging- a k way merge algorithm			
Mapping of Course Outcomes for Unit VI	CO4, CO6			
Learning Resources				
Text Books:				
<ol style="list-style-type: none"> 1. Horowitz, Sahani, Dinesh Mehata, "Fundamentals of Data Structures in C++", Galgotia Publisher, ISBN: 8175152788, 9788175152786. 2. M Folk, B Zoellick, G. Riccardi, "File Structures", Pearson Education", ISBN:81-7758-37-5 3. Peter Brass, "Advanced Data Structures", Cambridge University Press, ISBN: 978-1-107-43982-5 				

Reference Books:

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

e-Books:

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

MOOC/ Video Lectures available at:

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

@The CO-PO Mapping Matrix

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



Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
210253: Software Engineering

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Lecture: 03 Hours/Week	03	Mid_Semester(TH): 30 Marks End_Semester(TH): 70 Marks
Prerequisite Courses : 110005: Programming and Problem Solving		
Companion Course : ---		

Course Objectives:

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

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

Course Outcomes:

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

- CO1:** **Analyze** software requirements and formulate design solution for a software.
CO2: **Design** applicable solutions in one or more application domains using software engineering approaches that integrate ethical, social, legal and economic concerns.
CO3: **Apply** new software models, techniques and technologies to bring out innovative and novelistic solutions for the growth of the society in all aspects and evolving into their continuous professional development.
CO4: **Model** and design User interface and component-level.
CO5: **Identify** and handle risk management and software configuration management.
CO6: **Utilize** knowledge of software testing approaches, approaches to verification and validation.
CO7: **Construct** software of high quality – software that is reliable, and that is reasonably easy to understand, modify and maintain efficient, reliable, robust and cost-effective software solutions.

Course Contents

Unit I	Introduction to Software Engineering and Software Process Models	(06Hours)
Software Engineering Fundamentals: Introduction to software engineering, The Nature of Software, Defining Software, Software Engineering Practice. Software Process: A Generic Process Model, defining a Framework Activity, Identifying a Task Set, Process Patterns, Process Assessment and Improvement, Prescriptive Process Models, The Waterfall Model, Incremental Process Models, Evolutionary Process Models, Concurrent Models, A Final Word on Evolutionary Processes. Unified Process, Agile software development: Agile methods, plan driven and agile development.		
#Exemplar/Case Studies	Agile Tools- JIRA	
*Mapping of Course Outcomes for Unit I	CO1, CO3, CO7	
Unit II	Software Requirements Engineering and Analysis	(07 Hours)



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:												
<ol style="list-style-type: none"> Roger Pressman, "Software Engineering: A Practitioner's Approach", McGraw Hill, ISBN 0-07-337597-7 Ian Sommerville, "Software Engineering", Addison and Wesley, ISBN 0-13-703515-2 												
Reference Books:												
<ol style="list-style-type: none"> Carlo Ghezzi, "Fundamentals of Software Engineering", PHI, ISBN-10: 0133056996 Rajib Mall, "Fundamentals of Software Engineering", PHI, ISBN-13: 978-8120348981 Pankaj Jalote, "An Integrated Approach to Software Engineering", Springer, ISBN 13: 9788173192715. S K Chang, "Handbook of Software Engineering and Knowledge Engineering", World Scientific, Vol I, II, ISBN: 978-981-02-4973-1 Tom Halt, "Handbook of Software Engineering", Clanye International, ISBN- 10: 1632402939 												
e-books:												
<ul style="list-style-type: none"> https://ebookpdf.com/roger-s-pressman-software-engineering 												
MOOC/ Video Lectures available at:												
<ul style="list-style-type: none"> https://swayam.gov.in/nd1_noc19_cs69/preview https://swayam.gov.in/nd2_cec20_cs07/preview 												
<u>@The CO-PO Mapping Matrix</u>												
CO PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	2	-	-	-	-	-	-	-	-	-	-
CO2	1	-	-	-	-	2	2	2	-	-	-	-
CO3	-	-	2	-	-	2	-	-	-	-	-	-
CO4	-	2	2	-	-	-	-	-	-	-	-	-
CO5	-	2	2	-	-	-	-	-	-	-	-	-
CO6	-	2	2	-	-	-	-	-	-	-	-	-
CO7	1	-	1	1	-	-	-	-	-	-	-	-

Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217530: Management Information Systems

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

Prerequisite Courses, if any: ---

Companion Course, if any: ---

Course Objectives:

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

Course Outcomes:

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

CO1 : Explain the concepts of Management Information System and Business intelligence for MIS.

CO2 : Illustrate the need of information systems in global business and ethical issues.

CO3 : List the IT infrastructure components and explain security in the Information System.

CO4 : Demonstrate the importance of project management and extend its use in the international information system.

CO5 : Illustrate the concepts of decision support systems for business applications.

CO6 : Relate artificial intelligence and data science for Management Information System.

Course Contents

Unit I	An Overview of Management Information System	(07 Hours)
Management information system: Concept, MIS: Definition, Role of MIS, Impact of MIS, MIS & the User, Management as a Control System: The functions of Management, Managerial Roles, The Levels of Management[R3]. MIS: A Support to the Management, Management effectiveness and MIS, Organization as a System. Decision Making, Information, Knowledge and Business intelligence, Business intelligence for MIS.		
#Exemplar/Case Studies	Case study on General Life insurance company	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	Organization, Management and Network Enterprise	(07Hours)
Information systems in today's global business: The Role of information system, Perspective's on Information System. Global E-business and collaboration: Business Processes, Types of Information Systems. System for Collaboration and Team Work: Tools and technologies for collaboration and team work, E-mail and Instant Messaging, Social Networking, Virtual worlds, Internet based Collaboration Environments. Information system organization and strategy, Ethical and social issues in information system.		

#Exemplar/Case Studies	Collaboration & Innovation at Procter and Gamble(P&G)	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	Information Technology Infrastructure	(07 Hours)
IT infrastructure and Emerging Technologies: IT infrastructure and its components, Hardware and software platform trends, Management issues. Foundation of Business intelligence: Databases and information management. Telecommunication, The Internet and Wireless technology, Securing information systems: system vulnerability, Business value of security and control.		
#Exemplar/Case Studies	IPL Teams strike Gold with information Technology	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Key System Applications for Digital Age	(07 Hours)
Achieving operational Excellence and customer intimacy : Enterprise Applications, E-Commerce : Digital Markets and Digital Goods , Managing knowledge, Enhancing Decision Making , Building information Systems, Managing project : The importance of project Management, the business value of information systems, Managing project risk, Managing Global Systems: The growth of international information systems, organizing international information systems, Technology issues and opportunities for global value chain.		
#Exemplar/Case Studies	CoCa-Cola: “Opening Happiness” with a New Project Management System	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Business Applications	(07 Hours)
Introduction to e-business systems: Functional Business systems, cross functional Enterprise systems. Customer Relationship Management: The Business focus, Enterprise Resource Planning: The business backbone, Supply chain Management: Business Network. Electronic Commerce Systems: Fundamentals, e-commerce applications and issues. Decision support systems : Decision support in Business, DSS Components, Decision Supports Trends, OLTP, Data Mining for Decision Support, Knowledge Management System.		
#Exemplar/Case Studies	Amazon Vs Walmart: Which giant will dominate E-commerce?	
Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Artificial Intelligence & Data Science for MIS	(07 Hours)
Business and AI, An overview of Artificial Intelligence, Neural Network, Fuzzy Logic System, Genetic Algorithms, Virtual Reality, Intelligent Agents, Expert Systems: Components, Applications, Developing Expert Systems, The Value of Expert Systems: Benefits & Limitations.		
MIS in Data Science: Transition into data science for a Business Intelligence (BI)/MIS professional: performing detective analytics and generate insights from reports, statistics to support your insights about reports, present your findings to the right group, explore an open-source tool to generate reports OR to perform detective analysis, the model building / predictive modeling steps, Methods to evaluate		

your model's performance.

#Exemplar/Case Studies	Cisco Systems, Netflix.
Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

- Waman S. Javadekar," Management Information System: A Global Digital Enterprise Perspective", McGraw Hill Education Pvt. Ltd. 5th Edition, ISBN – 13:978-1-25-902669-0.
- James A. O'Brien, George M Marakas, "Management Information Systems", The McGraw-Hill Companies, 7th Edition, ISBN-0-07-062-003-2.

Reference Books:

- Kenneth C. Laudon, Jane P. Laudon, "Management information Systems: Managing the Digital Firm", Perason, 12th Edition, ISBN-978-81-317-8746-5.
- James A. O'Brien," Management Information Systems: Managing information Technology in the Business Enterprise", Tata McGraw Hill Edition, 6th Edition, ISBN- 0-07-058739-6.
- Robert Schultheis, Marry summer, "Management information system: The Manager's View", Tata McGraw Hill Edition, 4th Edition, ISBN-0-07-463879-3.
- Gordon B.Davis, Margrethe H. Olson, "Management Information Systems : Conceptual Foundations, Structure and Development", Tata McGraw Hill Edition, 2nd Editon,ISBN-13:978-0-07-040267-6

e-Books:

- https://repository.dinus.ac.id/docs/ajar/Kenneth_C.Laudon,Jane_P_.Laudon - Management Information Sysrem 13th Edition .pdf
- <https://www.sohailuniversity.edu.pk/wp-content/uploads/2018/12/Management-Information-Systems-O'Brien.pdf>
- <https://sctevtservices.nic.in/docs/website/pdf/140304.pdf>

MOOC Courses:

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

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

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

@The CO-PO mapping table

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

<p style="text-align: center;">Savitribai Phule Pune University Second Year of Artificial Intelligence and Data Science (2020 Course) 217531: Internet of Things Laboratory</p>		
Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 Hours/Week	02	Term Work (TW): 50 Marks Practical(PR): 25 Marks
Prerequisite Courses: Programming and Problem Solving (110005), Basic Electronics Engineering (104010)		
Companion Course: Internet of Things (217529)		
<p>Course Objectives:</p> <ul style="list-style-type: none"> • Hardware platforms and operating systems commonly used in IoT systems. • Help the students in providing a good learning environment and also work with real time problems faced in day to day life. 		
<p>Course Outcomes:</p> <p>On completion of the course, learner will be able to–</p> <p>CO1: Understand IOT Application Development using Raspberry Pi/ Beagle board/ Arduino board CO2: Develop and modify the code for various sensor based applications using wireless sensor modules and working with a variety of modules like environmental modules. CO3: Make use of Cloud platform to upload and analyse any sensor data</p>		
<p>Guidelines:</p> <p>Lab Assignments: Following is list of suggested laboratory assignments for reference. Laboratory Instructors may design a suitable set of assignments for their respective course at their level. Beyond curriculum assignments and mini-project may be included as a part of laboratory work. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. The Inclusion of a few optional assignments that are intricate and/or beyond the scope of curriculum will surely be the value addition for the students and it will satisfy the intellectuals within the group of the learners and will add to the perspective of the learners. For each laboratory assignment, it is essential for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorial may be as per guidelines of authority.</p> <p>• Term Work: Term work is continuous assessment that evaluates a student's progress throughout the semester. Term work assessment criteria specify the standards that must be met and the evidence that will be gathered to demonstrate the achievement of course outcomes. Categorical assessment criteria for the term work should establish unambiguous standards of achievement for each course outcome. They should describe what the learner is expected to perform in the laboratories or on the fields to show that the course outcomes have been achieved. It is recommended to conduct an internal monthly practical examination as part of continuous assessment.</p> <p>• 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.</p> <p>• Laboratory Journal: Program codes with sample output of all performed assignments are to be submitted as softcopy. Use of DVD or similar media containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journals may be avoided. Submission of journal/ term work in the form of softcopy is desirable and appreciated.</p> <p>Suggested List of Laboratory Experiments/Assignments</p> <p>Student should perform all assignments from Group A, at least 8 experiments with all experiments from group B and any 1 assignment from Group C. (Use suitable programming language/Tool for implementation)</p>		

List of Assignments

Group A

1. Study of Raspberry-Pi/ Beagle board/ Arduino and other microcontroller (History & Elevation)
2. Study of different operating systems for Raspberry-Pi /Beagle board/Arduino. Understanding the process of OS installation
3. Study of different GATES (AND, OR, XOR), Sensors and basic binary operations.
4. Study of Connectivity and configuration of Raspberry-Pi /Beagle board/Arduino circuit with basic peripherals like LEDS. Understanding GPIO and its use in the program.

Group B

5. Write a program using Arduino to control LED (One or more ON/OFF). Or Blinking
6. Create a program that illuminates the green LED if the counter is less than 100, illuminates the yellow LED if the counter is between 101 and 200 and illuminates the red LED if the counter is greater than 200
7. Create a program so that when the user enters ‘b’ the green light blinks, ‘g’ the green light is illuminated ‘y’ the yellow light is illuminated and ‘r’ the red light is illuminated
8. Write a program that asks the user for a number and outputs the number squared that is entered
9. Write a program to control the color of the LED by turning 3 different potentiometers. One will be read for the value of Red, one for the value of Green, and one for the value of Blue
10. Write a program read the temperature sensor and send the values to the serial monitor on the computer
11. Write a program so it displays the temperature in Fahrenheit as well as the maximum and minimum temperatures it has seen
12. Write a program to show the temperature and shows a graph of the recent measurements
13. Write a program using piezo element and use it to play a tune after someone knocks
14. Understanding the connectivity of Raspberry-Pi /Beagle board circuit / Arduino with IR sensor. Write an application to detect obstacle and notify user using LEDs

Group C

15. Study of ThingSpeak – an API and Web Service for the Internet of Things (Mini Project: Same can be done parallel with PBL)
16. Write an application to control the operation of hardware simulated traffic signals. (Mini Project: Same can be done parallel with PBL)
17. Develop a Real time application like smart home with following requirements: When the user enters into the house the required appliances like fan, light should be switched ON. Appliances should also get controlled remotely by a suitable web interface. The objective of this application is that students should construct complete Smart applications in groups. (Mini Project: Same can be done parallel with PBL)
18. Write an application for stopwatch or countdown timer. (Mini Project: Same can be done parallel with PBL)

Learning Resources

Text Books:

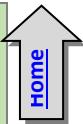
1. Alan G. Smith, “ Introduction to Arduino: A piece of cake”
2. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012. ISBN : 9781439892992

Reference Books:

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

@The CO-PO mapping table

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO12
CO1	2	1	3	--	--	--	--	--	--	--	--	--
CO2	--	2	3	--	--	--	--	--	--	--	--	--
CO3	--	--	3	2	--	--	--	--	--	--	--	3



Savitribai Phule Pune University
Second Year of Computer Engineering (2019 Course)
217532: Data Structures and Algorithms Laboratory

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

Prerequisite Courses: **110005: Programming and Problem Solving,**
217522: Data Structures Laboratory

Companion Course : **210252: Data Structures and Algorithms**

Course Objectives:

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

Course Outcomes:

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

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

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and **handwritten write-up** of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. **Program codes with sample output of all performed assignments are to be submitted as softcopy.**

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

Guidelines for Laboratory / Term Work Assessment

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

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of

Hungarian notation, proper indentation and comments. Use of open source software is to be encouraged. In addition to these, instructor may assign one real life application in the form of a mini-project based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

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

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

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

Guidelines for Practical Examination

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

Virtual Laboratory:

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

Suggested List of Laboratory Experiments/Assignments

Sr. No	Group A
1	Consider telephone book database of N clients. Make use of a hash table implementation to quickly look up client's telephone number. Make use of two collision handling techniques and compare them using number of comparisons required to find a set of telephone numbers
2	Implement all the functions of a dictionary (ADT) using hashing and handle collisions using chaining with / without replacement. Data: Set of (key, value) pairs, Keys are mapped to values, Keys must be comparable, Keys must be unique. Standard Operations: Insert(key, value), Find(key), Delete(key)
3	For given set of elements create skip list. Find the element in the set that is closest to some given value. (note: Decide the level of element in the list Randomly with some upper limit)
4	To create ADT that implement the "set" concept. a. Add (new Element) -Place a value into the set , b. Remove (element) Remove the value c. Contains (element) Return true if element is in collection, d. Size () Return number of values in collection Iterator () Return an iterator used to loop over collection, e. Intersection of two sets , f. Union of two sets, g. Difference between two sets, h. Subset
Group B	
5	A book consists of chapters, chapters consist of sections and sections consist of subsections. Construct a tree and print the nodes. Find the time and space requirements of your method.
6	Beginning with an empty binary search tree, Construct binary search tree by inserting the values in the order given. After constructing a binary tree - i. Insert new node, ii. Find number of nodes in longest path from root, iii. Minimum data value found in the tree, iv. Change a tree so that the roles of the left and right pointers are swapped at every node, v. Search a value
7	Construct an expression tree from the given prefix expression eg. +-a*bc/def and traverse it using post order traversal (non recursive) and then delete the entire tree.
8	Read for the formulas in propositional calculus. Write a function that reads such a formula and creates its binary tree representation. What is the complexity of your function?
9	Convert given binary tree into threaded binary tree. Analyze time and space complexity of the algorithm.

10	Consider threading a binary tree using preorder threads rather than inorder threads. Design an algorithm for traversal without using stack and analyze its complexity.
11	A Dictionary stores keywords and its meanings. Provide facility for adding new keywords, deleting keywords, updating values of any entry. Provide facility to display whole data sorted in ascending/ Descending order. Also find how many maximum comparisons may require for finding any keyword. Use Binary Search Tree for implementation.
12	Implement a file compression algorithm that uses binary tree. Your program should allow the user to compress and decompress messages containing alphabets using the standard Huffman algorithm for encoding and decoding.
Group C	
13	Represent a given graph using adjacency matrix/list to perform DFS and using adjacency list to perform BFS. Use the map of the area around the college as the graph. Identify the prominent land marks as nodes and perform DFS and BFS on that.
14	There are flight paths between cities. If there is a flight between city A and city B then there is an edge between the cities. The cost of the edge can be the time that flight take to reach city B from A, or the amount of fuel used for the journey. Represent this as a graph. The node can be represented by airport name or name of the city. Use adjacency list representation of the graph or use adjacency matrix representation of the graph. Check whether the graph is connected or not. Justify the storage representation used.
15	You have a business with several offices; you want to lease phone lines to connect them up with each other; and the phone company charges different amounts of money to connect different pairs of cities. You want a set of lines that connects all your offices with a minimum total cost. Solve the problem by suggesting appropriate data structures.
16	Tour operator organizes guided bus trips across the Maharashtra. Tourists may have different preferences. Tour operator offers a choice from many different routes. Every day the bus moves from starting city S to another city F as chosen by client. On this way, the tourists can see the sights alongside the route travelled from S to F. Client may have preference to choose route. There is a restriction on the routes that the tourists may choose from, the bus has to take a short route from S to F or a route having one distance unit longer than the minimal distance. Two routes from S to F are considered different if there is at least one road from a city A to a city B which is part of one route, but not of the other route.
17	Consider the scheduling problem. n tasks to be scheduled on single processor. Let t ₁ , ..., t _n be durations required to execute on single processor is known. The tasks can be executed in any order but one task at a time. Design a greedy algorithm for this problem and find a schedule that minimizes the total time spent by all the tasks in the system. (The time spent by one is the sum of the waiting time of task and the time spent on its execution.)
Group D	
18	Given sequence k = k ₁ < k ₂ < ... < k _n of n sorted keys, with a search probability p _i for each key k _i . Build the Binary search tree that has the least search cost given the access probability for each key?
19	A Dictionary stores keywords and its meanings. Provide facility for adding new keywords, deleting keywords, updating values of any entry. Provide facility to display whole data sorted in ascending/ Descending order. Also find how many maximum comparisons may require for finding any keyword. Use Height balance tree and find the complexity for finding a keyword
Group E	
20	Consider a scenario for Hospital to cater services to different kinds of patients as Serious (top priority), b) non-serious (medium priority), c) General Checkup (Least priority). Implement the priority queue to cater services to the patients.
21	Implement the Heap/Shell sort algorithm implemented in Java demonstrating heap/shell data structure with modularity of programming language

22	Read the marks obtained by students of second year in an online examination of particular subject. Find out maximum and minimum marks obtained in that subject. Use heap data structure. Analyze the algorithm.
----	---



Group F

23	Department maintains a student information. The file contains roll number, name, division and address. Allow user to add, delete information of student. Display information of particular employee. If record of student does not exist an appropriate message is displayed. If it is, then the system displays the student details. Use sequential file to main the data.
24	Company maintains employee information as employee ID, name, designation and salary. Allow user to add, delete information of employee. Display information of particular employee. If employee does not exist an appropriate message is displayed. If it is, then the system displays the employee details. Use index sequential file to maintain the data.
25	Implementation of a direct access file -Insertion and deletion of a record from a direct access file
26	Assume we have two input and two output tapes to perform the sorting. The internal memory can hold and sort m records at a time. Write a program in java for external sorting. Find out time complexity.

Mini-Projects/ Case Study

27	Design a mini project using C++ which will use the different data structure with or without C++ library and show the use of specific data structure on the efficiency (performance) of the code.
28	Design a mini project to implement Snake and Ladders Game using Python.
29	Design a mini project to implement a Smart text editor.
30	Design a mini project for automated Term work assessment of student based on parameters like daily attendance, Unit Test / Prelim performance, Students achievements if any, Mock Practical.

@The CO-PO Mapping Matrix

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO12
CO1	1	2	2	-	-	-	-	-	-	-	-	-
CO2	-	2	2	-	-	-	-	-	-	-	-	-
CO3	-	2	2	1	-	-	-	-	-	-	-	-
CO4	1	2	1	1	-	-	-	-	-	-	-	-
CO5	1	1	2	2	-	-	-	-	-	-	-	-



Savitribai Phule Pune University

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

217533: Project Based Learning II

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

Course Objectives:

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

Course Outcomes:

CO1: Identify the real life problem from societal need point of view

CO2: Choose and compare alternative approaches to select most feasible one

CO3: Analyze and synthesize the identified problem from technological perspective

CO4: Design the reliable and scalable solution to meet challenges

CO5: Evaluate the solution based on the criteria specified

CO6: Inculcate long life learning attitude towards the societal problems

Course Contents

Preamble:

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

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

Group Structure:

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

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



Selection of Project/Problem:

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

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

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

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

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

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

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

Assessment:

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

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

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

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

1. Individual assessment for each student (Understanding individual capacity, role and involvement in the project)
2. Group assessment (roles defined, distribution of work, intra-team communication and togetherness)
3. Documentation and presentation

Evaluation and Continuous Assessment:

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

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

Recommended parameters for assessment/evaluation and weightage:

1. Idea Inception and Awareness /Consideration of -Environment/ Social /Ethics/ Safety measures/Legal aspects (10%)
2. Outcomes of PBL/ Problem Solving Skills/ Solution provided/ Final product (Individual assessment and team assessment) (40%)
3. Documentation (Gathering requirements, design and modelling, implementation/execution, use of technology and final report, other documents) (15%)
4. Demonstration (Presentation, User Interface, Usability) (20%)
5. Contest Participation/ publication (15%)

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



the work undertaken.

Note :

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

Text Books:

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

Reference Books:

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

Tutors Role in Project Based Learning

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

Change of Mindset

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

Designing Problem

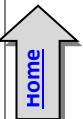
- Considering the prior knowledge of the students, their ability and creativity, problem statement should be designed.
- For 2nd year PBL students the tutor should place more emphasis on getting the students to perform higher-level tasks.
- It is important for tutors to design problems that are anchored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

Basic function of the tutor

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

Grouping

- Study the background and profile of each student.



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

Assessment of Learning

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

Student's Role in PBL

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

Inquiry Skills

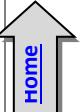
- Students in PBL are expected to develop critical thinking abilities by constantly relating:
- What they read to do?
- What they want to do with that information?
- They need to analyze information presented within the context of finding answers.
- Modeling is required so that the students can observe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

Information Literacy

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

Information literacy involves the ability to:

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



- Sorting and assessing of information in general

Collaborative learning

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

Interpersonal Skills

- Interpersonal skills relating to group process are essential for effective problem solving and learning.
- It is important that students are made aware of these inter personal skills.
- Consensual decision making skills, Dialogue and discussion skills, Team maintenance skills
- Conflict management skills and Team leadership skills.

Students who have these skills have a better opportunity to learn than students who do not have these skills and Time Management

Resources

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

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

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

Meta-cognitive Skills

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

Reflection Skills

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

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

@The CO-PO Mapping Matrix

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



Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217534: Code of Conduct

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Tutorial: 01 Hours/Week	01^{\$}	Term work^{\$}: 25 Marks

Preamble:

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

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

Course Objectives:

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

Course Outcomes:

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

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

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

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

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

Course Contents

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

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

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

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

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

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

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

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

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

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

Following are contents to be covered in tutorial session-

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

- Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct
3. **Ethics as Design** - Doing Justice to Moral Problems : Engineer's Responsibility for Safety - Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk
 4. **Workplace Responsibilities and Rights** - Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination
 5. **Computers, Software, and Digital Information**
 6. **Responsibility for the Environment**

#Exemplar/Case Studies :

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

Guidelines for Conduction:

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

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

Suggested set of Activities

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

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

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

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

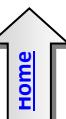
Method – Role play a professional situation where an engineer is not competent and is trying to copy the work of a colleague and claim credit for that work. Ask observing students to react to that situation. Alternatively, a short video that clearly shows unethical behavior can be played and ask viewers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

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

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

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

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



- 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 be encouraged to allow healthy discussion
Outcome – Become aware of unethical code of conduct in the professional world and how to follow a moral compass especially when one reaches positions of power.
- 7. Purpose** – Provide an insight into rights and ethical behavior.
Method – Movies like The Social Network can be played and students can be asked to discuss their opinion about collegiality, intellectual property, friendship and professional relationships
Outcome – help them look at success stories from an ethical point of view. Develop critical thinking and evaluation of circumstances.
- 8. Purpose** – Make students contemplate about ideal and safe professional environment and decide on making right decisions based on codes of conduct
Method – Students can be asked to write down 5 most important codes of conduct that they feel that every computer engineer should follow. After evaluation by teacher / experts, the collection of codes can be converted into a handbook to be given to every student as a memoir to help them in their professional life.
Outcome – Introspection and think about how to shape the professional environment. Also, when they carry back with them their own codes of conduct, they could feel bound to adhere to these ethics.

Term Work Assessment Guidelines

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

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

Recommended Assessment and Weightage Parameters:

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

Term Work Assessment Guidelines

Students must submit the report of all conducted activities conducted during Tutorial (Outside Classroom) of at least 04 activities (out of 07 activities) from group (of 02-03) students.

The brief guidelines for report preparations are as follows:

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

Recommended Assessment and Weightage Parameters:

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

Web Links:

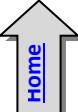
- <https://www.ieee.org/about/compliance.html>
- <https://www.cs.cmu.edu/~bmclarens/ethics/caseframes/91-7.html>
- <https://www.nspe.org/>
- http://www.ewh.ieee.org/soc/pes/switchgear/presentations/tp_files/2017-1_Thurs_Shiffbauer_Singer_Engineering_Ethics.pdf

MOOC/ Video lectures available at:

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

@The CO-PO Mapping Matrix

CO\ PO	PO 1	PO2	PO3	PO 4	PO5	PO6	PO7	PO 8	PO9	PO1 0	PO1 1	PO12
CO1	-	-	-	-	-	-	2	2	-	-	-	-
CO2	-	-	-	-	-	-	2	2	-	-	-	-
CO3	-	-	-	-	-	-	3	2	-	-	-	-
CO4	-	-	-	-	-	-	2	3	-	-	-	-



Savitribai Phule Pune University
Second Year of Artificial Intelligence and Data Science (2020 Course)
217535: Audit Course 4

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

Criteria:

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

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

- | | |
|---|---|
| <ul style="list-style-type: none"> • Lectures/ Guest Lectures • Visits (Social/Field) and reports • Demonstrations | <ul style="list-style-type: none"> • Surveys • Mini-Project • Hands on experience on focused topic |
|---|---|

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

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

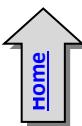
Audit Course 4 Options

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

Note: It is permitted to opt one of the audit courses listed at SPPU website too, if not opted earlier. [1]

<http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202017/Forms/AllItems.aspx>

http://www.unipune.ac.in/university_files/syllabi.htm



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

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

Course Objectives

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

Course Outcomes

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

CO1: Understand the global water cycle and its various processes

CO2: Understand climate change and their effects on water systems

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

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

Course Contents

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

References:

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

@The CO-PO Mapping Matrix

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



Savitribai Phule Pune University

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

217535-II: Intellectual Property Rights and Patents

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

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

Course Objectives:

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

Course Outcomes:

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

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

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

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

Course Contents

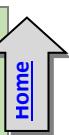
1. **Introduction to Intellectual Property Law** – The Evolutionary Past - The IPRT Tool Kit - Para-Legal Tasks in Intellectual Property Law
2. **Introduction to Trade mark** – Trade mark Registration Process – Post registration Procedures - Trade mark maintenance - Transfer of Rights – Inter parties Proceeding – Infringement - Dilution Ownership of Trade mark
3. **Introduction to Copyrights** – Principles of Copyright Principles - The subjects Matter of Copy right – The Rights Afforded by Copyright Law – Copy right Ownership, Transfer and duration – Right to prepare Derivative works
4. **Introduction to Trade Secret** – Maintaining Trade Secret – Physical Security – Employee Limitation - 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, New Delhi, ISBN-10:0070077177

@The CO-PO Mapping Matrix

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



Savitribai Phule Pune University

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

217535-III: The Science of Happiness

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

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

Course Objectives

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

Course Outcomes

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

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

CO2: Learn how to increase your own happiness

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

CO4: Understand what is mindfulness and its real world applications

Course Contents

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

References:

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University

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

217535-IV: Yoga and Meditation



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

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

Course Objectives:

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

Course Outcomes:

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

- CO1:** Understand philosophy and religion as well as daily life issues will be challenged and enhanced.
- CO2:** Enhances the immune system.
- CO3:** Intellectual and philosophical understanding of the theory of yoga and basic related Hindu scriptures will be developed.
- CO4:** Powers of concentration, focus, and awareness will be heightened.

Course Contents

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

References:

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

[@The CO-PO Mapping Matrix](#)

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

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

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

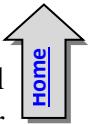
1. Katakana basic Script, Denoting things (nominal and pre nominal demonstratives), Purchasing at the Market / in a shop / mall (asking and stating price)
2. Katakana : Modified kana, double consonant, letters with ya, yu, yo, Long vowels, Describing time, describing starting and finishing time (kara ~ 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)

@The CO-PO Mapping Matrix

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



Acknowledgement

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

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

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

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

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

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

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

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

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

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

Thank you for all your efforts!

Professor (Mrs.) Dr. Varsha H. Patil, Chairman, and
Members- Dr. Shirish Sane, Dr. Sunil Bhirud, Dr. Manik Dhore, Dr. Pramod Patil, Dr. Girish Khilari, Dr. Sachin Lodha, Dr. Parikshit Mahalle, Dr. Venkatesharan, Dr. Geetanjali Kale, Dr. Suhasini Itkar, Dr. R. V. Patil and Dr. P. M. Yawalkar.

**Board of Studies (BoS), Computer Engineering, Faculty of Science and Technology,
Savitribai Phule Pune University.**

Task Force at Curriculum Design



1. Advisors, the Team of Board of Studies-

Dr. Varsha Patil (Chairman), Dr. Shirish Sane, Dr. Sunil Bhirud, Dr. Manik Dhore, Dr. Girish Khilari, Dr. Sachin Lodha, Dr. Parikshit Mahalle, Dr. Pramod Patil, Dr. Venkatesharan, Dr. Geetanjali Kale, Dr. Suhasini Itkar, Dr. R. V. Patil and Dr. P. M. Yawalkar.

2. Team Leader-Dr. Prashant M. Yawalkar

3. Teams, Course Design-

Name of Course	Team Leaders	Team Members	
Discrete Mathematics	Dr. Nihar Ranjan Dr. Mrs. Archana Chaugule	Dr. S. K. Pathan Dr. Mrs. Snehal Kamlapur Dr. Mrs. Shital Sonawane	Dr. V. S. Pawar Dr. Kailash Shaw Prof. Ravindra Rathore
Fundamental of Data Structure & Lab	Dr. S R Dhore Dr. Prashant Dhotre	Dr. Mrs. Gitanjali Shinde Dr. Mrs. A. P. Kale Prof. Anupama Phakatkar	Dr. Vinayak Kottawar Prof. Ajitkumar Shitole Prof. Ms. Snehal Kulkarni
Object Oriented Programming	Dr. Amol Dhumane Dr. Mrs. S. K. Wagh	Prof. D. D. Sapkal Prof. Ms. Poojashree Vidap Prof. K. M. Sanghavi	Dr. Mrs. R. A. Satao Dr. Mrs. Swati Bhavsar Dr. Mrs. Chiwhane Prof Vaibhav Dabhade
Computer Graphics and Lab	Dr. Swati Bhavsar Dr. Mrs. N. F. Shaikh	Dr. Kamini Nalawade Prof. P. P. Vaidya Prof. Dr. Aparna Junnarkar	Dr. Shabnam Farook Sayyad Prof. Mrs. Laxmi Sisode Prof Madhuri Shinde
Operating Systems and Lab	Dr. Snehal Kamlapur	Dr. Vaishali Pawar Prof A. S. Banait	Mr. Tushar Kute
Humanities and Social Studies & Code of Conduct	Dr. Mrs. R. A. Khan	Prof. Mrs. Vaidehi Banerjee Prof. N. L. Bhale	Prof. S. P. Pingat Mr. Ranjeet Gawande
Statistics	Dr. Neeta Deshpande	Dr. Vaishali Tidke	Prof Radhika Chandwadkar
Software Engineering	Dr. Mrs. J. R. Prasad	Dr. Mrs. Manjusha Joshi Prof. Ms. Deipali Gore	Dr. Hanchate D.B. Prof. Sachin Shinde Ms. Poonam Dholi Prof Amol Gosavi
Internet of Things and Lab	Dr. Mahesh Sanghvi	Dr. Amol Potgantwar Dr. Prakash Kalavadekar	Prof Kainjan Sanghwi Prof Pankaj Devre
Data Structures and Algorithms & Lab	Dr. Dipak Patil Dr. Mrs. G. S Navale Dr. S. D. Babar	Dr. Nilesh Wankhede Dr. K. C. Nalavade Dr Mrs. A. R. Deshpande Prof. Ms. Pallavi Baviskar	Dr. Manoj Wakchaure Prof. Mrs. S. M. Bhadkumbhe Prof. Ms. Neha Patil Prof Samadhan Jadhav
Management Information System	Dr. Sriniwas Sonkar	Dr. Mubin Tamboli	Prof Vinay Suryawanshi Prof Vijay More
Project Based Learning	Dr. Mrs. Manisha Bhende Dr. Chaudhari Manohar	Dr. Saumitra Das Dr. D. T. Mane Dr. Swati Bhavsar	Prof. Subhash Rathod Prof. Mrs. Swati Shinde Prof. Kushal P. Birla Mr. Pravin Andhale

[Back to Table of Contents](#)

Curriculum for

Third Year of Artificial Intelligence and Data Science (2019 Course)

(With effect from 2022-23)



<http://unipune.ac.in>

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

**Third Year of Artificial Intelligence and Data Science
(2019 Course)
(With effect from 2022-23)**

Prologue

It is with great pleasure and honor that I share the syllabi for Third Year of Artificial Intelligence and 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 revising syllabus, honest and sincere efforts are put to tune Computer Engineering 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.

Syllabus revision is materialized with sincere efforts, active participation, expert opinions and suggestions from domain professionals. 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.

Thanks,

Dr. Varsha H. Patil
Chairman, Board of Studies (Computer Engineering), SPPU, Pune

links for First and Second Year Artificial Intelligence and Data Science Curriculum 2019:

1. <http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/Rules%20and%20Regulations%20F.E.%202019%20Patt%201.012020.pdf>
2. <http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/First%20Year%20Engineering%202019%20Patt.Syllabus%2005.072019.pdf>
3. http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2021/SE_AI-DS_Curriculum_2021_28.06.2021.pdf

Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
(With effect from Academic Year 2022-23)

Table of Contents

Sr. No.	Title	Page Number
1.	<u>Program Outcomes</u>	4
2.	<u>Program Specific Outcomes</u>	4
3.	<u>Course Structure</u> (Course titles, scheme for teaching, credit, examination and marking)	5
4.	<u>General Guidelines</u>	7
5.	Course Contents (Semester V)	10 To 56
	310241: <u>Data Base Management Systems</u>	10
	317521: <u>Computer Networks</u>	13
	310252: <u>Web Technology</u>	16
	310253: <u>Artificial Intelligence</u>	19
	** : <u>Elective I</u>	22
	317523: <u>Software Laboratory I</u>	34
	317524: <u>CN Laboratory</u>	38
	317525: <u>Elective I Laboratory</u>	40
	317526: <u>Seminar and Technical Communication</u>	48
	317527: <u>Environmental Studies</u>	50
	317528: <u>Audit Course 5</u>	52
6.	Course Contents (Semester VI)	58 To 102
	317529: <u>Data Science</u>	58
	317530: <u>Cyber Security</u>	61
	317531: <u>Artificial Neural Network</u>	64
	** : <u>Elective II</u>	67
	317533: <u>Software Laboratory II</u>	79
	317534: <u>Software Laboratory III</u>	82
	317535: <u>Internship</u>	87
	317536: <u>Mini Project</u>	91
	317537: <u>Audit Course 6</u>	97
7.	<u>Acknowledgement</u>	103
8.	<u>Task Force at Curriculum Design</u>	104

Savitribai Phule Pune University
Bachelor of Artificial Intelligence and 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 Artificial Intelligence and Data Science Program will demonstrate—

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

Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
(With effect from Academic Year 2022-23)

Semester-V															
Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme				
		Lecture	Practical	Tutoria l	Mid-Sem.	End-Sem.	Term	work	Practic al	Oral	Total	Lecture	Practical	Tutoria l	
310241	Data Base Management System	03	-	-	30	70	-	-	-	-	100	03	-	-	
317521	Computer Networks	03	-	-	30	70	-	-	-	-	100	03	-	-	
310252	Web Technology	03	-	-	30	70	-	-	-	-	100	03	-	-	
310253	Artificial Intelligence	03	-	-	30	70	-	-	-	-	100	03	-	-	
**	Elective I	03	-	-	30	70	-	-	-	-	100	03	-	-	
317523	Software Laboratory I	-	04	-	-	-	25	25	-	50	-	02	-	02	
317524	CN Laboratory	-	02	-	-	-	25	25	-	50	-	01	-	01	
317525	Elective I Laboratory	-	02	-	-	-	25	-	25	50	-	01	-	01	
317526	Seminar and Technical Communication	-		01	-	-	25	-	-	25	-	-	01	01	
317527	Environmental Studies	-	-	01	-	-	25	-	-	25	-	-	01	01	
Total		15	08	02	150	350	125	50	25	700	15	04	02	21	
317528	Audit Course 5											Grade			
												Total	15	04	02
** Elective-I Options		Audit Course 5 Options													
317522 (A) Embedded Systems & Security		317528(A) Emotional Intelligence													
314445 (C) Design Thinking		317528(B) Industrial Safety And Environment Consciousness													
317522 (B) Pattern Recognition		317528(C) 3D Printing													
310245 (B) Human Computer Interface		317528(D) Foreign Language													
Software Laboratory I (Assignments from)		317528(E) MOOC- Learn New Skills													
Software Laboratory I (Assignments from)		Data Base Management System and Artificial Intelligence													

Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
(With effect from Academic Year 2022-23)

Semester-VI

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												
317529	Data Science	04	-	-	30	70	-	-	-	100	03	--	-	03											
317530	Cyber security	04	-	-	30	70	-	-	-	100	03	-	-	03											
317531	Artificial Neural Network	04	-	-	30	70	-	-	-	100	03	-	-	03											
**	Elective II	04	-	-	30	70	-	-	-	100	03	-	-	03											
317533	Software Laboratory II	-	04	-	-	-	25	25	-	50	-	02	-	02											
317534	Software Laboratory III	-	04	-	-	-	50	25	-	75	-	02	-	02											
317535	Internship**	-	--	-	-	-	50	-	50	100	-	04	-	04											
317536	Mini Project (CS and Elective-II)	-	02	-	-	-	50	-	25	75	-	01	-	01											
Total		16	10	-	120	280	175	50	75	700	12	09	-	21											
317537	Audit Course 6	Grade											Total												
		Total											12												
Elective-II Options		Audit Course 6 Options																							
317532(A) Robotics and Automation		317537(A) Digital and Social Media Marketing																							
317532(B) Natural Language Processing		317537(B) Sustainable Energy Systems																							
310254(C) Cloud Computing		317537(C) Leadership and Personality Development																							
310254(D) Software Modeling and Architecture		317537(D) Foreign Language																							
		317537(E) MOOC- Learn New Skills																							
Software Laboratory II (Assignments from)		Artificial Neural Network																							
Software Laboratory III (Assignments from)		Data Science																							
Mini Project (Assignments from)		Cyber Security and Elective II																							
Internship**		Internship guidelines are provided in course curriculum sheet.																							
## Hours/Week for Theory Course in Third Year of Engineering, Semester VI:																									
As per the apex bodies' recommendations and guidelines, it is need of the day to train the pre-final year students for the industrial readiness through internship. As per the guidelines of AICTE, the duration of internship is 4-6 weeks after completion of semester V and before commencement of semester VI, so it is apparent that the contact hours of the TE students need to be managed meticulously. It becomes mandatory as per the structure that 4 credits for internship must be earned by the students. Per semester, 15 weeks duration that is suggested ideally by the affiliated university will eventually reduce to fruitful 12 weeks after the implementation of the revised curriculum (2019 Course). With the evaluatory introduction of internship in the structure, we are left with the choice of 4 theory courses in the sixth semester with 12 weeks instead of traditional 15 weeks. To balance the credits and to achieve the minimum required contact hours, it is the reasonable choice to allot 4 hours / week for each theory course of the sixth semester of Third year of Engineering. The additional one lecture/ week will definitely be instrumental in achieving the largest of minimum contact hours. As such there is no correspondence of weekly load and credits earned, the credit allotted per course remain intact despite of the change. So it is almost imperative that the commencement of VI Semester need to be approx. 3 weeks beyond the schedule.																									

General Guidelines

1. Every undergraduate program has its own objectives and educational outcomes. These objectives and outcomes are furnished by considering various aspects and impacts of the curriculum. These **Program Outcomes (POs)** are categorically mentioned at the beginning of the curriculum (ref: NBA Manual). There should always be a rationale and a goal behind the inclusion of a course in the curriculum. Course Outcomes though highly rely on the contents of the course; many-a-times are generic and bundled. The **Course Objectives, Course Outcomes** and **CO-PO mappingsmatrix** 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. **@:CO and PO Mapping Matrix**(Course Outcomes and Program Outcomes)- The **expected** attainment mapping matrix at end of course contents, indicates the correlation levels of 3, 2, 1 and ‘-’. The notation of 3, 2 and 1 denotes substantially (high), moderately (medium) and slightly (low). The mark ‘-’ indicates that there is no correlation between the respective CO and PO.
3. **#:Elaborated examples/Case Studies-** For each course, contents are divided into six units-I, II, III, IV, V and VI. Elaborated examples/Case Studies are included at the end of each unit to explore how the learned topics apply to real world situations and need to be explored so as to assist students to increase their competencies, inculcating the specific skills, building the knowledge to be applicable in any given situation along with an articulation. One or two sample exemplars or case studies are included for each unit; instructor may extend the same with more. **Exemplar/Case Studies may be assigned as self-study by students and to be excluded from theory examinations.**
4. *:For each unit contents, the desired content attainment mapping is indicated with Course Outcome(s). Instructor may revise the same as per their viewpoint.
5. For laboratory courses, set of suggested assignments is provided for reference. Laboratory Instructors may design suitable set of assignments for respective course at their level. **Beyond curriculum assignments and mini-project may be included as a part of laboratory work.** The Inclusion of few optional assignments that are intricate and/or beyond the scope of curriculum will surely be the value addition for the students and it will satisfy the intellectuals within the group of the learners and will add to the perspective of the learners.
6. For each laboratory assignment, it is essential for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorial may be as per guidelines of authority.
7. For each course, irrespective of the examination head, the instructor should motivate students to read and publish articles, research papers related to recent development and invention in the field.
8. For laboratory, instructions have been included about the conduction and assessment of laboratory work. **These guidelines are to be strictly followed. Use of open source software is appreciated.**
9. **Term Work^[1]**—Term work is continuous assessment that evaluates a student's progress throughout the semester^[1]. Term work assessment criteria specify the standards that must be met and the evidence that will be gathered to demonstrate the achievement of course outcomes. Categorical assessment criteria for the term work should establish unambiguous standards of achievement for each course outcome. They should describe what the learner is expected to perform in the laboratories or on the fields to show that the course outcomes have been achieved. **It is recommended to conduct internal monthly practical examination as part of continuous assessment.**

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

10. **Laboratory Journal-** Program codes with sample output of all performed assignments are to be submitted as softcopy. Use of DVD or similar media containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Submission of journal/ term work in the form of softcopy is desirable and appreciated.
11. **Tutorial^[1]** - Tutorials can never be an individual course but an additional aid to the learners. Tutorials help the learners to inculcate the contents of the course with focused efforts on small group of the learners. Tutorial conduction should concentrate more on simplifying the intricacies converging to clear understanding and application. Assessment of tutorial work is to be done in a manner similar to assessment of term-work; do follow same guidelines.
12. **Audit Course^[1]** The student registered for audit course shall be awarded the grade AP/PP (Audit Course Pass) and the grade 'AP'/'PP' shall be included in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory performance and secured a passing grade in that audit course. No grade points are associated with this 'AP'/'PP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself.
13. UGC has issued the UGC (Credit Framework for online learning courses through SWAYAM) Regulation 2016 advising the Universities to identify courses where credits can be transferred on to the academic record of the students for courses done on SWAYAM. AICTE has also put out gazette notification in 2016 and subsequently for adoption of these courses for credit transfer^[2].
SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity, and quality. This is done through a platform that facilitates hosting of the courses to be accessed by anyone, anywhere at any time. Courses delivered through SWAYAM are interactive, prepared by the best teachers in the country and are available, free of cost to any learner. However, learners wanting a SWAYAM certificate should register for the final proctored exams that come at a fee and attend in-person at designated center on specified dates. Eligibility for the certificate is generally announced on the course page. Universities/colleges approving credit transfer for these courses can use the marks/certificate obtained in these courses for the same.^[2]
14. ****Internship:**
Engineering internships are intended to provide students with an opportunity to apply conceptual knowledge from academics to the realities of the field work/training. The following guidelines are proposed to give academic credit for the internship undergone as a part of the Third Year Engineering curriculum.

For more rules, pattern and assessment of semester examination refer^[1]

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

[1] http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/Rules%20and%20Regulations%20F.E.%202019%20Patt_10.01.2020.pdf
[2] <https://swayam.gov.in/about>

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

Semester V

Savitribai Phule Pune University**Third Year of Artificial Intelligence and Data Science (2019 Cou**[Home](#)**310241: Database Management Systems****Teaching Scheme:****Lecture: 03 Hours/Week****Credit: 03****Examination Scheme:****Mid-Sem (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:** Discrete Mathematics (210241), Data Structures and Algorithms (210252)**Companion Course:** Software LaboratoryI(317523)**Course Objectives:**

- To understand the fundamental concepts of Database Management Systems
- To acquire the knowledge of database query languages and transaction processing
- To understand systematic database design approaches
- To acquire the skills to use a powerful, flexible, and scalable general-purpose databases to handle Big Data
- To be familiar with advances in databases and applications

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 Transaction Management concepts in real-time situations**CO5:** Use NoSQL databases for processing unstructured data**CO6:** Differentiate between Complex Data Types and analyze the use of appropriate data types**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	Database Transaction Management	07 Hours
Introduction to Database Transaction, Transaction states, ACID properties, Concept of Schedule, Serial Schedule. Serializability: Conflict and View, Cascaded Aborts, Recoverable and Non-recoverable Schedules. Concurrency Control: Lock-based, Time-stamp based Deadlock handling. Recovery methods: Shadow-Paging and Log-Based Recovery, Checkpoints. Log-Based Recovery: Deferred Database Modifications and Immediate Database Modifications.		
#Exemplar/Case Studies	Study of Transaction Management in Postgre SQL	
*Mapping of Course Outcomes for Unit IV	CO3, CO4	
Unit V	NoSQL Databases	07 Hours
Introduction to Distributed Database System, Advantages, Disadvantages, CAP Theorem. Types of Data: Structured, Unstructured Data and Semi-Structured Data. NoSQL Database: Introduction, Need, Features. Types of NoSQL Databases: Key-value store, document store, graph, wide column stores, BASE Properties, Data Consistency model, ACID Vs BASE, Comparative study of RDBMS and NoSQL. MongoDB (with syntax and usage): CRUD Operations, Indexing, Aggregation, MapReduce, Replication, Sharding.		
#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	Advances in Databases	07 Hours
Emerging Databases: Active and Deductive Databases, Main Memory Databases, Semantic Databases. Complex Data Types: Semi-Structured Data, Features of Semi-Structured Data Models. Nested Data Types: JSON, XML. Object Orientation: Object-Relational Database System, Table Inheritance, Object-Relational Mapping. Spatial Data: Geographic Data, Geometric Data.		
#Exemplar/Case Studies	Applications of advanced databases 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
2. Connally T, Begg C., "Database Systems", Pearson Education, ISBN 81-7808-861-4
3. Pramod J. Sadalage and Martin Fowler, "NoSQL Distilled", Addison Wesley, ISBN-10: 0321826620, ISBN-13: 978-0321826626

Reference Books :

1. C J Date, "An Introduction to Database Systems", Addison-Wesley, ISBN: 0201144719
2. S.K.Singh, "Database Systems: Concepts, Design and Application", Pearson Education, ISBN 978-81-317-6092-5
3. Kristina Chodorow, Michael Dierolf, "MongoDB: The Definitive Guide", O'Reilly Publications, ISBN: 978-1-449-34468-9
4. Adam Fowler, "NoSQL For Dummies", John Wiley & Sons, ISBN-1118905628
5. Kevin Roebuck, "Storing and Managing Big Data - NoSQL, HADOOP and More", Emereopty Limited, ISBN: 1743045743, 9781743045749
6. Joy A. Kreibich, "Using SQLite", O'REILLY, ISBN: 13:978-93-5110-934-1
7. Ivan Bayross, "SQL, PL/SQL the Programming Language of Oracle", BPB Publications ISBN: 9788176569644, 9788176569644
8. Seema Acharya, "Demystifying NoSQL", Wiley Publications, ISBN: 9788126579969

e-Books :

1. SQL and Relational Theory
 - a. (How to Write Accurate SQL code), C.J. Date, O'REILLY Publication
2. SQL A Beginner's Guide, Andy Oppel, Robert Sheldon, McGraw Hill Publication

MOOCs Courses Links:

- <http://www.nptelvideos.com/lecture.php?id=6518>

@ The CO-PO Mapping Matrix

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
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
Third Year of Artificial Intelligence and Data Science (2019 Course)
317521: Computer Networks

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: CN Laboratory(317527)

Course Objectives:

- To understand the Basics concepts of networking standards, protocols and technologies.
- To learn the different signal transmission, multiplexing techniques.
- To learn the role of protocols at various layers in the protocol stacks.
- To learn the different IEEE standards.

Course Outcomes:

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

CO1: Summarize fundamental concepts of Computer Networks, architectures, protocols and technologies

CO2: Analyze the working of physical layer protocols.

CO3: Analyze the working of different routing protocols and mechanisms

CO4: Implement client-server applications using sockets

CO5: Illustrate role of application layer with its protocols, client-server architectures

CO6: Summarize concepts of MAC and ethernet.

Course Contents

Unit I	Fundamentals of Computer Network	(06 Hours)
Definition, uses of computer network, Network Devices : Bridge, Switch, Router, Gateway, Access Point, Network Topologies : Bus, Star, Ring, Tree, Mesh, Hybrid, Types of Network : LAN, MAN, WAN, PAN, Ad-Hoc Network, Networks Software, Protocol, Design issues for the Network layers. Types of Transmission Media : Guided Media, Unguided Media. Network Architecture : Client-Server, Peer To Peer, Hybrid. Network Models : OSI and TCP/IP Model, Types of Addressing : Physical addressing, Logical addressing, Port addressing and other addressing.		
#Exemplar/Case Studies	Demonstrate the LAN Network	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	Physical Layer	(7 Hours)

Functions of Physical Layer, Data And Signals, Digital Transmission, Analog Transmission, **Transmission Impairment**: Attenuation, Distortion, Noise, **Bandwidth utilization: Multiplexing** : Frequency-Division Multiplexing , Wavelength Division, synchronous time-division multiplexing, statistical time-division multiplexing. **Spread Spectrum**: Frequency Hopping (FHSS) and Direct Sequence Spread Spectrum (DSSS), **Switching**: circuit switching, packet switching, message switching, **Types of cable connection**: Straight through connection, Cross over Connection. **Line Coding Schemes**: Manchester and Differential Manchester Encodings.

#Exemplar/Case Studies	Study of college campus network	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	Network Layer	(7 Hours)
<p>Introduction: Functions of Network layer. Switching Techniques: Circuit switching, Message Switching, Packet Switching. IP Protocol: Classes of IP (Network addressing), IPv4, IPv6, Network Address Translation, Sub-netting, CIDR. Network layer Protocols: ARP, RARP, ICMP, IGMP. Network Routing and Algorithms: Static Routing, Dynamic Routing, Distance Vector Routing, Link State Routing, Path Vector. Routing Protocols: RIP, OSPF, BGP, MPLS. Routing in MANET: AODV, DSR, Mobile IP.</p>		
#Exemplar/Case Studies	Simulation of Network Layer Protocol	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Transport Layer	(7 Hours)
<p>Process to Process Delivery, Services, Socket Programming. Elements of Transport Layer Protocols: Addressing, Connection establishment, Connection release, Flow control and buffering, Multiplexing, Congestion Control. Transport Layer Protocols: TCP and UDP, SCTP, RTP, Congestion control and Quality of Service (QoS), Differentiated services, TCP and UDP for Wireless networks.</p>		
#Exemplar/Case Studies	Simulation of Demonstration of Transport layer protocols.	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Application Layer	(6 Hours)
<p>Client Server Paradigm, Peer to Peer Paradigm, Communication using TCP and UDP services, Domain Name System (DNS), HyperText Transfer Protocol (HTTP), Email: SMTP, MIME, POP3, Webmail, FTP, TELNET, Dynamic Host Control Protocol (DHCP), Simple Network Management Protocol (SNMP).</p>		
#Exemplar/Case Studies	Study of Application Layer protocols using network protocol analyzer. e.g. Wireshark	
Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Medium Access Control	(6 Hours)
<p>Channel allocation: Static and Dynamic, Multiple Access Protocols: Pure and Slotted ALOHA, CSMA, WDMA, IEEE 802.3 Standards and Frame Formats, CSMA/CD, Binary Exponential Back -off algorithm, Fast Ethernet, Gigabit Ethernet, IEEE 802.11a/b/g/n and IEEE 802.15 and IEEE 802.16 Standards, Frame formats, CSMA/CA.</p>		
#Exemplar/Case Studies	Study of Medium Access Control protocols	
Mapping of Course Outcomes for Unit VI	CO6	

Learning Resources

Text Books:

1. Fourauzan B., "Data Communications and Networking", 5th Edition, TataMcGraw-Hill, Publications, ISBN: 0-07 - 058408 - 7
2. Andrew S. Tanenbaum, "Computer Networks", 5th Edition, Pearson India, 2012.
3. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on Approach", Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515
4. Behrouz A. Forouzan, TCP/IP Protocol Suite, McGraw Hill Education, ISBN: 978-0-07-070652-1,
4th Edition.

Reference Books:

- 1.L. Peterson and B. Davie, "Computer Networks: A Systems Approach", 5th Edition, Morgan-Kaufmann, 2012.
- 2.Kurose, Ross "Computer Networking a Top Down Approach Featuring the Internet", Pearson, ISBN-10:0132856204
3. Matthew S. G, "802.11 Wireless Networks", O'Reilly publications, ISBN: 81-7656-992-5
4. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols" Prentice Hall, ISBN-10: 8131706885; ISBN-13: 978-8131706886
5. Holger Karl and Andreas Willing, "Protocols and Architectures for Wireless Sensor Networks", Wiley India , ISBN: 9788126533695
6. Eldad Perahia, Robert Stacey, "Next Generation Wireless LANs", Cambridge, ISBN-10: 1107016762;
ISBN- 13: 978-1107016767
7. Efraim Turban, Linda Volonino, Gregory R. Wood "Computer Networking a Top Down Approach Featuring the Internet", 10th Edition, Wiley; ISBN13: 978-1-118-96126-1

e-Books:

MOOC Courses:

@ The CO-PO Mapping Table

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1	1	-	2	1	1	-	-	2	2	-	1
CO2	1	1	-	1	1	1	-	-	2	2	-	1
CO3	2	3	-	2	1	1	-	-	2	2	-	1
CO4	1	1	1	-	1	-	-	-	1	-	1	1
CO5	1	3	-	-	1	-	1	1	-	-	-	-
CO6	1	1	-	2	1	1	-	-	2	2	-	1

310252: Web Technology**Teaching Scheme:****Theory :03 Hours/Week****Credit: 03****Examination Scheme:****Mid-Sem (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:****Companion Course:** Database Management Systems (310241), Computer Networks (317521)**Course Objectives:**

- To learn the fundamentals of web essentials and markup languages
- To use the Client side technologies in web development
- To use the Server side technologies in web development
- To understand the web services and frameworks

Course Outcomes:

On completion of the course, learners should be able to

CO1: Implement and analyze behavior of web pages using HTML and CSS**CO2:** Apply the client side technologies for web development**CO3:** Analyze the concepts of Servlet and JSP**CO4:** Analyze the Web services and frameworks**CO5:** Apply the server side technologies for web development**CO6:** Create the effective web applications for business functionalities using latest web development platforms**Course Contents**

Unit I	Web Essentials and Mark-up language- HTML	07 Hours
<p>The Internet, basic internet protocols, the World Wide Web, HTTP Request message, HTTP response message, web clients, web servers. HTML: Introduction, history and versions. HTML elements: headings, paragraphs, line break, colors and fonts, links, frames, lists, tables, images and forms, Difference between HTML and HTML5. CSS: Introduction to Style Sheet, CSS features, CSS core syntax, Style sheets and HTML, Style rule cascading and inheritance, text properties. Bootstrap.</p>		
#Exemplar/Case Studies	Create a style sheet suitable for blogging application using HTML and using style sheet	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Client Side Technologies: JavaScript and DOM	07 Hours
<p>JavaScript: Introduction to JavaScript, JavaScript in perspective, basic syntax, variables and data types, statements, operators, literals, functions, objects, arrays, built in objects, JavaScript debuggers. DOM: Introduction to Document Object Model, DOM history and levels, intrinsic event handling, modifying element style, the document tree, DOM event handling, jQuery, Overview of Angular JS.</p>		
#Exemplar/Case Studies	Enhancement in created blogging application using JavaScript (Add Entry feature)	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Java Servlets and XML	07 Hours

Servlet: Servlet architecture overview, A “Hello World” servlet, Servlets generating dynamic content, Servlet life cycle, parameter data, sessions, cookies, URL rewriting, other Servlet capabilities, data storage, Servlets concurrency, databases (MySQL) and Java Servlets. **XML:** XML documents and vocabularies, XML declaration, XML Namespaces, DOM based XML processing, transforming XML documents, DTD: Schema, elements, attributes. **AJAX:** Introduction, Working of AJAX.

#Exemplar/Case Studies	Develop server-side code for blogging application
*Mapping of Course Outcomes for Unit III	CO3

Unit IV	JSP and Web Services	07 Hours
JSP: Introduction to Java Server Pages, JSP and Servlets, running JSP applications, Basic JSP, JavaBeans classes and JSP, Support for the Model-View-Controller paradigm, JSP related technologies. Web Services: Web Service concepts, Writing a Java Web Service, Writing a Java web service client, Describing Web Services: WSDL, Communicating Object data: SOAP. Struts: Overview, architecture, configuration, actions, interceptors, result types, validations, localization, exception handling, annotations.		

#Exemplar/Case Studies	Transform the blogging application from a loose collection of various resources (servlets, HTML documents, etc.) to an integrated web application that follows the MVC paradigm
*Mapping of Course Outcomes for Unit IV	CO3, CO4

Unit V	Server Side Scripting Languages	07 Hours
PHP: Introduction to PHP, uses of PHP, general syntactic characteristics, Primitives, operations and expressions, output, control statements, arrays, functions, pattern matching, form handling, files, cookies, session tracking, using MySQL with PHP, WAP and WML. Introduction to ASP.NET: Overview of the .NET Framework, Overview of C#, Introduction to ASP.NET, ASP.NET Controls, Web Services. Overview of Node JS.		

#Exemplar/Case Studies	Use of PHP in developing blogging application.
*Mapping of Course Outcomes for Unit V	CO5, CO6

Unit VI	Ruby and Rails	07 Hours
Introduction to Ruby: Origins & uses of Ruby, scalar types and their operations, simple input and output, control statements, fundamentals of arrays, hashes, methods, classes, code blocks and iterators, pattern matching. Introduction to Rails: Overview of Rails, Document Requests, Processing Forms, Rails Applications and Databases, Layouts, Rails with Ajax. Introduction to EJB.		

#Exemplar/Case Studies	Study of dynamic web product development using ruby and rails
*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

- Jeffrey C.Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035
- Robert W. Sebesta, "Programming the World Wide Web", 4th Edition, Pearson education, 2008

Reference Books :

1. Marty Hall, Larry Brown, "Core Web Programming", Second Edition, Pearson Education, 2001, ISBN 978-0130897930.
2. H.M. Deitel, P.J. Deitel and A.B. Goldberg, "Internet & World Wide Web How To Program", Third Edition, Pearson Education, 2006, ISBN 978-0131752429.
3. Chris Bates, "Web Programming Building Internet Applications", 3rd Edition, Wiley India, 2006.
4. Xue Bai et al, "The web Warrior Guide to Web Programming", Thomson, 2003.

e-Books :

- <https://www.w3.org/html/>
- HTML, The Complete Reference <http://www.htmlref.com/>
- <http://w3schools.org/>
- <http://php.net/>
- <https://jquery.com/>
- <https://developer.mozilla.org/en-US/docs/AJAX>
- <http://www.tutorialspoint.com/css/>

MOOCs Courses link:

- <http://www.nptelvideos.in/2012/11/internet-technologies.html>
- <https://freevideolectures.com/course/2308/internet-technology/25video lecture by Prof. Indranil Sengupta, IIT, Kharagpur>
- <https://www.digimat.in/nptel/courses/video/106105191/L01.html>
- http://www.nptelvideos.com/php/php_video_tutorials.php

@ The CO-PO Mapping Matrix

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12
CO1	1	1	2	1	1	-	-	-	-	-	-	-
CO2	-	2	1	3	1	-	-	-	1	-	-	-
CO3	2	-	2	1	-	1	-	-	-	-	1	-
CO4	1	3	1	2	2	1	-	1	-	-	-	1
CO5	1	1	2	-	3	-	1	1	-	1	-	-
CO6	2	1	-	2	1	1	-	1	-	-	-	-

Savitribai Phule Pune University**Third Year of Artificial Intelligence and Data Science (2019 Course)**[Home](#)**310253: Artificial Intelligence****Teaching Scheme:****Lecture: 03 Hours/Week****Credit: 03****Examination Scheme:****Mid-Sem (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:** Programming and Problem solving (110005),

Data Structures and Algorithms (210252)

Companion Course: Software Laboratory I (317523)**Course Objectives:**

- To understand the concept of Artificial Intelligence (AI) in the form of various Intellectual tasks
- To understand Problem Solving using various peculiar search strategies for AI
- To understand multi-agent environment in competitive environment
- To acquaint with the fundamentals of knowledge and reasoning
- To devise plan of action to achieve goals as a critical part of AI
- To develop a mind to solve real world problems unconventionally with optimality

Course Outcomes:*After completion of the course, students should be able to***CO1:** Identify and apply suitable Intelligent agents for various AI applications**CO2:** Build smart system using different informed search / uninformed search or heuristic approaches**CO3:** Identify knowledge associated and represent it by ontological engineering to plan a strategy to solve given problem**CO4:** Apply the suitable algorithms to solve AI problems**CO5:** Implement ideas underlying modern logical inference systems**CO6:** Represent complex problems with expressive yet carefully constrained language of representation**Course Contents**

Unit I	Introduction	07 Hours
Introduction to Artificial Intelligence, Foundations of Artificial Intelligence, History of Artificial Intelligence, State of the Art, Risks and Benefits of AI, Intelligent Agents, Agents and Environments, Good Behavior: Concept of Rationality, Nature of Environments, Structure of Agents.		
#Exemplar/Case Studies	Kroger: How This U.S. Retail Giant Is Using AI And Robots To Prepare For The 4th Industrial Revolution	
*Mapping of Course Outcomes for Unit I	CO1, CO4	
Unit II	Problem-solving	07 Hours
Solving Problems by Searching, Problem-Solving Agents, Example Problems, Search Algorithms, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions, Search in Complex Environments, Local Search and Optimization Problems.		
#Exemplar/Case Studies	4th Industrial Revolution Using AI, Big Data And Robotics	

*Mapping of Course Outcomes for Unit II	CO2, CO4	
Unit III	Adversarial Search and Games	07 Hours
Game Theory, Optimal Decisions in Games, Heuristic Alpha–Beta Tree Search, Monte Carlo Tree Search, Stochastic Games, Partially Observable Games, Limitations of Game Search Algorithms, Constraint Satisfaction Problems (CSP), Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs.		
#Exemplar/Case Studies	Machine Learning At Google: The Amazing Use Case Of Becoming A Fully Sustainable Business	
*Mapping of Course Outcomes for Unit III	CO3, CO4	
Unit IV	Knowledge	07 Hours
Logical Agents, Knowledge-Based Agents, The Wumpus World, Logic, Propositional Logic: A Very Simple Logic, Propositional Theorem Proving, Effective Propositional Model Checking, Agents Based on Propositional Logic, First-Order Logic, Representation Revisited, Syntax and Semantics of First-Order Logic, Using First-Order Logic, Knowledge Engineering in First-Order Logic.		
#Exemplar/Case Studies	BBC To Launch AI - Enabled Interactive Radio Show For Amazon Echo And Google Home Chat bots	
*Mapping of Course Outcomes for Unit IV	CO3, CO4	
Unit V	Reasoning	07 Hours
Inference in First-Order Logic, Propositional vs. First-Order Inference, Unification and First-Order Inference, Forward Chaining, Backward Chaining, Resolution, Knowledge Representation, Ontological Engineering, Categories and Objects, Events, Mental Objects and Modal Logic, Reasoning Systems for Categories, Reasoning with Default Information		
#Exemplar/Case Studies	The Amazing Ways How Wikipedia Uses Artificial Intelligence	
*Mapping of Course Outcomes for Unit V	CO4, CO5	
Unit VI	Planning	07 Hours
Automated Planning, Classical Planning, Algorithms for Classical Planning, Heuristics for Planning, Hierarchical Planning, Planning and Acting in Nondeterministic Domains, Time, Schedules, and Resources, Analysis of Planning Approaches, Limits of AI, Ethics of AI, Future of AI, AI Components, AI Architectures.		
#Exemplar/Case Studies	The Amazing Ways Samsung Is Using Big Data, Artificial Intelligence And Robots To Drive Performance	
*Mapping of Course Outcomes for Unit VI	CO4, CO6	
Learning Resources		
Text Books:		
<ol style="list-style-type: none"> 1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Third edition, Pearson, 2003, ISBN :10: 0136042597 2. Deepak Khemani, “A First Course in Artificial Intelligence”, McGraw Hill Education(India), 2013, ISBN : 978-1-25-902998-1 3. Elaine Rich, Kevin Knight and Nair, “Artificial Intelligence”, TMH, ISBN-978-0-07-008770-5 		

Reference Books:

1. Nilsson Nils J , “Artificial Intelligence: A new Synthesis”, Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4
2. Patrick Henry Winston, “Artificial Intelligence”, Addison-Wesley Publishing Company, ISBN: 0-201-53377-4
3. Andries P. Engelbrecht-Computational Intelligence: An Introduction, 2nd Edition-Wiley India- ISBN: 978-0-470-51250-0
4. Dr. Lavika Goel, “Artificial Intelligence: Concepts and Applications”, Wiley publication, ISBN: 9788126519934
5. Dr. Nilakshi Jain, “Artificial Intelligence, As per AICTE: Making a System Intelligent”, Wiley publication, ISBN: 9788126579945

e-Books :

- <https://cs.calvin.edu/courses/cs/344/kvlinden/resources/AIMA-3rd-edition.pdf>
- <https://www.cin.ufpe.br/~tfl2/artificial-intelligence-modern-approach.9780131038059.25368.pdf>
- <http://aima.cs.berkeley.edu/>

MOOCs Courses link:

- <https://nptel.ac.in/courses/106/102/106102220/>
- <https://nptel.ac.in/courses/106/105/106105077/>
- <https://nptel.ac.in/courses/106/105/106105078/>
- <https://nptel.ac.in/courses/106/105/106105079/>

@ The CO-PO Mapping Matrix

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

SavitribaiPhule Pune University**Third Year of Artificial Intelligence and Data Science (2019 Course)****Elective I****317522(A): Embedded Systems and Security**

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	Mid-Semester(TH): 30 Marks End-Semester(TH): 70 Marks

Prerequisite Courses, if any: 217529: Internet of Things**Companion Course, if any: Elective I Laboratory (317525)****Course Objectives:**

- To understand what is an Embedded systems & its development tools
- To understand ARM 7 architecture and its features
- To learn the Embedded C programming
- To study RTOS concepts
- To learn Embedded Linux and its toolchain
- To learn Embedded system security threats

Course Outcomes:

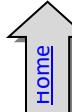
On completion of the course, learner will be able to—

CO1: Differentiate between Embedded System & general computing systems**CO2:** Describe ARM MCU Architecture and its features**CO3:** Design Embedded firmware using Embedded C**CO4:** Apply the fundamentals of RTOS to design Embedded Systems**CO5:** Build the Embedded Linux based Embedded System**CO6:** Summarize Embedded system security threats and solutions**Course Contents**

Unit I	Introduction to Embedded Systems	(6 Hours)
Fundamental of Embedded system, Embedded systems v/s general purpose systems, classification of Embedded system, Applications, Purpose of an Embedded System, Typical embedded system, Elements of ES, Core of Embedded system, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other components, Characteristics and Quality attributes of Embedded systems, Application and domain specific examples of Embedded systems.		
#Exemplar/Case Studies	Embedded System for Smart Card reader/Embedded System for Robotic Arm Movement control using web server	
Mapping of Course Outcomes for Unit I		
Unit II	ARM Architecture	(8 Hours)
The ARM Core, The ARM Microcontroller, RISC vs CISC, Advance Features, Architecture versions, ARM cortex, Features of ARM which makes it Special, Operating modes, Register set, Mode switching, Conditional Flags, Interrupt vector table, Features of the LPC 214x Family, Block diagram of LPC 2148 ARM microcontroller, Memory Map, GPIO, Timer, PWM Unit, UART, ARM 9 & Cortex introduction/features.		
#Exemplar/Case Studies	Study any one ARM 7 based development board. Example: STM Nucleo Board/MCB 2140	
Mapping of Course Outcomes for Unit II		
Unit III	Embedded Firmware Design and Development	(8 Hours)
Embedded firmware design approach, Embedded firmware development languages: Assembly and high level languages, conversion steps, advantages and limitations, Programming in Embedded C: C v/s Embedded c, Compiler v/v cross compiler, Library & user defined functions, Pre-processors and Macros, Programming of ARM 7 GPIO pins & peripherals like Timer, PWM, UART using C, Integration of Hardware & firmware, IDE's for embedded system development, types of file generated on cross compilation, simulators, emulators and debugging.		

#Exemplar/Case Studies		
Mapping of Course Outcomes for Unit III		Study KEIL or any suitable Embedded Development Tools
Unit IV	Embedded/Real Time Operating System Concepts	(8 Hours)
RTOS, The Real Time Kernel, its basic functions, Hard & soft real time, Tasks, Process & Threads, Multitasking, its types, Task Scheduling, Task Communication, Mailbox, Semaphore, how to Choose RTOS. Introduction to RTOS µCOS-II, its features, source files and system level functions.		
#Exemplar/Case Studies		Study the features of µCOS-III
Mapping of Course Outcomes for Unit IV		CO3
Unit V	Embedded Linux	(8 Hours)
Introduction to embedded Linux, Embedded Linux system architecture, Advantages of Linux, examples of embedded Linux based systems, Embedded hardware for Linux, software components, Linux kernel features, kernel architecture and configuration, root file systems, device tree. Embedded Linux development environment, cross compilation toolchain, boot loaders, tool utilities such as Minicomp, Busybox, Redboot, Libc, Device drivers- concept, architecture, types, sample characteristic of device driver.		
#Exemplar/Case Studies		Study the kernel Analysis system
Mapping of Course Outcomes for Unit V		CO4
Unit VI	Embedded Systems Security	(6 Hours)
Security Threats of ES, Side-Channel Analysis Attacks in Embedded System Devices, Network attacks, Software Attacks, Control hijacking attacks, Reverse engineering, Malware, Memory and bus attacks, Cold Boot Attack. Injecting crafted packets or input, Eavesdropping, Brute-force search attacks. Effects of Attack: Denial-of-Service, Code execution, Integrity violation, Financial loss, Degraded level of protection, Security requirements for embedded devices, Challenges of Security Threats of ES, Counter measures.		
#Exemplar/Case Studies		VxWorks Debug Port Vulnerability
Mapping of Course Outcomes for Unit VI		CO6
Learning Resources		
Text Books:		
<ol style="list-style-type: none"> 1. Introduction to Embedded Systems, Shibu K V, MHE India 2. Embedded Systems: An Integrated Approach, Lyla Das, Pearson 		
Reference Books:		
<ol style="list-style-type: none"> 1. Raj Kamal, Embedded Systems – Architecture, Programming and Design, 2nd edition, TMH 2. Jean J.Labrosse, MicroC OS II, The Real-Time Kernel, 2nd edition, CMP Books 3. Chris Simmonds, Mastering Embedded Linux Programming, 2nd edition, Packt Publishing 4. Dr. K V K K Prasad, Embedded/Real Time Systems: Concepts, Design, & Programming, Dreamtech Press, New Delhi 5. Parag H Dave, Himanshu H. Dave, Embedded systems Concepts, design and programming, Pearson India 6. Embedded Systems Security, David Kleidermacher, Mike Kleidermacher 7. Frank Vahid and Tony Givargis, Embedded System Design – A Unified hardware/ Software introduction, 3rd edition, Wiley 		
e-Books:		
<ol style="list-style-type: none"> 1. https://bootlin.com/doc/training/embedded-linux/embedded-linux-slides.pdf 2. https://tec.gov.in/pdf/Studypaper/Embedded%20system%20security.pdf 		
MOOC Courses:		
<ol style="list-style-type: none"> 1. Embedded System Design With ARM, By Prof. IndranilSengupta, Prof. Kamalika Dutta, IIT Kharagpur 		
@The CO-PO mapping table		

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



SavitribaiPhule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
Elective I
314445 (C): Design Thinking

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

Prerequisite Courses, if any: Programming and Problem Solving, Software Engineering

Companion Course, if any: Elective I Laboratory (317525)

Course Objectives:

- To learn the Design thinking basic concepts.
- To identify the opportunities and challenges for design thinking innovation.
- To describe, define and ideate process of design thinking.
- To summarize the prototyping techniques.
- To enlist the activities carried out in Test and reflect phase of design thinking.
- To Interpret Design Thinking case studies.

Course Outcomes:

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

CO1: Identify need and features of design thinking.

CO2: Identify the opportunities and challenges for design thinking innovation.

CO3: Learn the process of design thinking using various tools.

CO4: Summarize and learn the various prototyping techniques.

CO5: Enlist the activities carried out in Test and reflect phase of design thinking.

CO6: Interpret the design thinking disruptive innovations through case studies.

Course Contents

Unit I	INTRODUCTION TO DESIGN THINKING	(06 Hours)
Introduction to Design and Design Thinking , Definition of Design Thinking, Need of Design Thinking, Features of Design Thinking, Problem Solving and Design, Design thinking as Strategy of Innovation, Use of Design Thinking, Design Thinking-Attributes, The Principles of Design Thinking, The Five-step Process of Design Thinking(Empathize, Define, Ideate, Prototype, Test),Design Thinking-A Solution basedthinking: Design Thinking vs. Scientific Method, Problem Focused vs. Solution Focused, Analysis vs.Synthesis, Divergent Thinking vs. Convergent Thinking , Roots of Design Thinking in Human Centric Design Process.		
#Exemplar/Case Studies	Understanding the Design Thinking Mindsets	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	EXPLORE AND EMPATHIZE	(06 Hours)
Explore- STEEP Analysis , Activity Systems, Stakeholder Analysis, Framed Opportunities Empathise- Observation, Problem statement, User Interviews- Interview for Empathy, Explorative Interview, Ask 5x Why, 5W+H questions (Design Thinking Toolbox), Needs Finding, Empathy Map, Persona Development, Customer Journey Map		
#Exemplar/Case Studies	Details of Creative Thinking Strategies	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	DEFINE AND IDEATE	(06 Hours)
Define- Define Point of view , “How might we ...” question, Storytelling, Context MappingIdeate-Brainstorming, 2x2 Matrix Ideate- Purpose, Methods & Tools, SCAMPER, SCAMPER for Ideation, SCAMPER template, AnalogousInspiration, IDEATION using Deconstruct & Reconstruct, User Experience Journey		
#Exemplar/Case Studies		

Mapping of Course Outcomes for Unit III	CO3	
Unit IV	PROTOTYPE	(06 Hours)
Get Visual, Design Principles, Determine What to Prototype, Storyboard		
Prototype- How to carry out Prototyping? Frequently used kinds of prototypes, Focused experiments – Critical Experience Prototype (CEP) & Critical Function Prototype (CFP), Crazy experiments – Darkhorse Prototype, Combined experiments – Funky prototype Prototyping -Paper Prototyping, Digital Prototyping- Wireframe vs Realistic Prototypes, HTML vs WYSIWYG Editors, Additional Tools for Prototyping, Working with a Developer, Prototype Examples		
#Exemplar/Case Studies	Understanding Design Thinking & People Centered Design	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	TEST AND REFLECT	(06 Hours)
Test- Testing Sheet , Feedback Capture Grid, Powerful questions in experience testing, Solution interview Structured Usability Testing, A/B Testing, Design Testing with Users, Exploring Visual Design Mock-Ups Choosing a Design Testing, Usability Testing, Reflect- I like, I wish, I wonder, Create a pitch, lean canvas lessons learned, Road map for implementation Evolve- Concept Synthesis, Viability Analysis(Impact Evaluation), Innovation Tool using user needs, CAP, 4s.		
#Exemplar/Case Studies	Study UberEATS	
Mapping of Course Outcomes for Unit V	CO5	
Unit VI	DISRUPTIVE INNOVATION	(06 Hours)
Reimagining the Trade Show Experience at IBM, Redesigning the Customer Contact Center at Toyota, Social Networking at MeYou Health, Rethinking Subsidized Meals for the Elderly at The Good Kitchen THE SOCIAL PROBLEM Design Thinking in Healthcare with IDEO, Design Thinking Transformed Airbnb, IBM Design Thinking: A Framework To Help Teams Continuously Understand and Deliver, UberEATS.		
#Exemplar/Case Studies	Design Thinking - Health Care Industry	
Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		
Text Books:		
1. Michael Lewrick, Patrick Link, Larry Leifer , “The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods”, March 2020 edition, ISBN: 978-1-119- 62921-4, WILEY Publication. 2. Mr Lee Chong Hwa (Lead Facilitator), “The Design Thinking: Guidebook”		
Reference Books:		
1. Russ Unger, Carolyn Chandler, “A Project Guide to UX Design For user experience designers in the field or in the making (Voices That Matter)”, 2nd Edition, ISBN 13: 978-0-321-81538-5 2. Karl T Ulrich, “Design – Creation of Artifacts in Society”, 1 st edition, ISBN 978-0-9836487-0-3, University of Pennsylvania 3. Tim Brown, “Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation”, ISBN- 9780061937743, Harper Collins, 2009. 4. Eli Woolery, “Design Thinking Handbook”, In-Vision publisher. 5. Jeanne Liedtka, Andrew King, Kevin Bennett, “Solving Problems with Design Thinking: TenStories Of “What Works”, Columbia Business School Publishing, E-ISBN 978-0-231-53605-9		
e-Books:		
1. Design Thinking - A Primer online course video lectures by IIT Madras (freevideolectures.com)		

2. NPTEL: Humanities and Social Sciences - NOC: Understanding Design Thinking & People Centered Design

3. NPTEL: Management - NOC: Design Thinking - A Primer

4. Design Thinking Transformed Airbnb: <https://review.firstround.com/How-design-thinkingtransformed-Airbnb-from-failing-startup-to-billion-dollar-business>

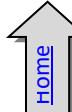
5. UberEATS: <https://medium.com/uber-design/how-we-design-on-the-ubereats-teamff7c41fffb76>

6. IBM Design Thinking: A Framework To Help Teams Continuously Understand and Deliver: <https://www.ibm.com/blogs/think/2016/01/ibm-design-thinking-a-framework-for-teams-tocontinuously-understand-and-deliver/>

MOOC Courses:

@The CO-PO mapping table

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



Savitribai Phule Pune University

Third Year of Artificial Intelligence and Data Science (2019 Course)

Elective I

317522(B): Pattern Recognition

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

Prerequisite Courses, if any: ---Basics of Automata Theory

Companion Course, if any:Elective I Laboratory (317525)

Course Objectives:

- To understand fundamentals of pattern recognition.
- To Study syntactic approach in pattern recognition.
- To study statistical approach in pattern recognition.
- To study artificial neural network-based pattern recognition.

Course Outcomes:

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

CO1: Distinguish variety of pattern recognition, classification and combination techniques.

CO2: Apply statistical pattern recognition approaches in variety of problems.

CO3: Elaborate different approaches of syntactic pattern recognition.

CO4: Differentiate graphical approach and grammatical inferences in syntactic pattern recognition.

CO5: Illustrate the artificial neural network-based pattern recognition

CO6: Apply unsupervised learning in pattern recognition.

Course Contents

Unit I	Introduction to Pattern Recognition	(07 Hours)
---------------	--	-------------------

Pattern Recognition, Classification and Description, Pattern and Feature Extraction with Examples: Patterns and Features, Pattern Distortions, Examples: Features Extraction Using Generalized Cylinders for 3-D object Description and Classification, Generating RST Invariant Features and Application to 2-D Figure Recognition, The Feature Vector and Feature Space, Classifiers, Decision Regions and Boundaries and Discriminant Functions, **Training and Learning in PR Systems:** using A Priori knowledge or Experience, Learning Curves, Training Approaches, **Pattern Recognition Approaches:** Statistical, Syntactic, Neural Patten Recognition Approach, Examples of Pattern Recognition Approaches.

#Exemplar/Case Studies	Black Box Approaches to Pattern Recognition
-------------------------------	--

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

Unit II	Statistical Pattern Recognition	(07 Hours)
----------------	--	-------------------

Introduction to statistical pattern recognition, The Gaussian case and class dependance, Discriminant function, Additional Examples, Extensions: Training, Alternative Classification Procedures, Unsupervised Approaches, Classifier Performance, Risk and Errors: Measurement of Classification Performance, General Measures of Classification Risk.

#Exemplar/Case Studies	statistical pattern recognition in image processing
-------------------------------	---

Mapping of Course Outcomes for Unit II	CO2
---	-----

Unit III	Syntactic Pattern Recognition	(07 Hours)
-----------------	--------------------------------------	-------------------

Overview, Qualifying structure in Pattern Description and Recognition, Grammar-Based Approach and Applications, Elements of Formal Grammars, Examples of String Generation as Pattern Description, Syntactic **Recognition Via Parsing and other Grammars**: -Recognition of Syntactic Descriptions, Parsing, CYK Parsing Algorithm, ATN in Parsing, Higher Dimensional Grammars, Stochastic Grammars and Applications.

#Exemplar/Case Studies	Block World Description	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Graphical Approaches & Grammatical Inference in Syntactic Pattern Recognition	(07 Hours)

Graphical Approaches: Graph Based Structural Representation, Graph Isomorphism, A Structured Strategy to Compare Attribute Graphs, Other Attributed Graph Distance or Similarity measures.

Learning Via Grammatical Inference: Learning Grammars, Problem formulation, Grammatical Inference (GI) Approaches, Procedures to Generate Constrained Grammars.

#Exemplar/Case Studies	Structural Unification Using Attributed Graphs	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Neural Pattern Recognition	(07 Hours)

Introduction to Neural Networks: Neurons and Neural Nets, Neural Network Structures for PR Applications, Physical Neural Networks, The Artificial Neural Network Model.

Introduction to Neural Pattern Associators and Matrix Approaches: Neural Network Based Pattern Associators, Matrix Approaches (Linear Associative Mappings) and Examples

#Exemplar/Case Studies	Hardware Realizations of Neural Network	
Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Feedforward Networks & Unsupervised Learning in Neural Pattern Recognition	(07 Hours)

Multilayer, Feedforward Network Structure, Training the Feedforward Network: The Delta Rule, Generalized Delta Rule(GDR), Extension of the DR for Units in the Hidden layers, Pattern Associator for Character Classification, **Unsupervised Learning in NeurPR: Self organizing Networks:** Introduction, Adaptive Resonance Architectures, Self-Organizing Feature Maps(Kohonen).

#Exemplar/Case Studies	Examples of Content Addressable Memory Applications in PR:Character Recognition, Relational Constraint Satisfaction(Coloring)
Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. ROBBERT SCHALKOFF, "Pattern Recognition: Statistical, Structural and Neural Approaches", Willey Publication, ISBN978-81-245-1370-3
2. R.O.Duda, P.E.Hart and D.G.Stork, "Pattern Classification", John Wiley,ISBN-978-0-471-05669-0

Reference Books:

1. Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis"
2. Andrew R. Webb, Keith D. Copsey, "Statistical Pattern Recognition", 3rd edition Wiley , ISBN:978-0-470-68227-2
3. Christopher M. Bishop, "Neural network for Pattern Recognition," Oxford University Press, ISBN-978-0-19-853864-6

e-Books:

- 1.<http://users.isr.ist.utl.pt/~wurmd/Livros/school/Bishop%20%20Pattern%20Recognition%20And%20Machine%20Learning%20-%20Springer%20%202006.pdf> 2.[https://darmanto.akacom.ac.id/pengenalanpola/Pattern%20Recognition%204th%20Ed.%20\(2009\).pdf](https://darmanto.akacom.ac.id/pengenalanpola/Pattern%20Recognition%204th%20Ed.%20(2009).pdf)
 3.https://www.inf.ed.ac.uk/teaching/courses/nlu/assets/reading/Gurney_et_al.pdf

MOOC Courses:

- 1.<https://nptel.ac.in/courses/117105101>
 2.<https://nptel.ac.in/courses/106106046>

@The CO-PO mapping table

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

Savitribai Phule Pune University**Third Year of Artificial Intelligence and Data Science (2019 Course)****Elective I**[Home](#)**310245(B): Human Computer Interface****Teaching Scheme:****Lecture: 03****Hours/Week****Credit: 03****Examination Scheme:****Mid-Sem (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:** Computer Graphics (210244), Software Engineering (210253)**Companion Course:** Elective I Laboratory (317525)**Course Objectives:**

- To understand the importance of HCI design process in software development
- To learn fundamental aspects of designing and implementing user interfaces
- To study HCI with technical, cognitive and functional perspectives
- To acquire knowledge about variety of effective human-computer-interactions
- To co-evaluate the technology with respect to adapting changing user requirements in interacting with computer

Course Outcomes:*On completion of the course, learners should be able to***CO1:** Design effective Human-Computer-Interfaces for all kinds of users**CO2:** Apply and analyze the user-interface with respect to golden rules of interface**CO3:** Analyze and evaluate the effectiveness of a user-interface design**CO4:** Implement the interactive designs for feasible data search and retrieval**CO5:** Analyze the scope of HCI in various paradigms like ubiquitous computing, virtual reality ,multi-media, World wide web related environments**CO6:** Analyze and identify user models, user support, and stakeholder requirements of HCI systems**Course Contents**

Unit I	Introduction and Foundation of HCI	07 Hours
<p>Foundation: Human Memory. Thinking: Reasoning and Problem Solving, Emotion, Individual Difference, Psychology and design of Interactive systems, The Computer-Text Entry Device, Positioning, Pointing, Display devices, Devices for virtual reality and 3D Interaction, The Interactions-Models of Interaction, Frameworks and HCI, Ergonomics, Interaction styles, Ergonomics, Elements of WIMP Interface, Interactivity, Measurable Human Factors, The context of Interaction. Importance of User Interface: Defining user Interface, Brief History of Human-Computer Interface, Good and Poor Design- Importance of good design.</p>		
#Exemplar/Case Studies	Paper prototype – Design elements of GUI	
*Mapping of Course Outcomes for Unit I	CO1,CO6	
Unit II	Human Perspective in Interaction Design Process	07 Hours

Know your user/client: Understanding how people interact with computers, Important human characteristics in Design, Human considerations in design of Business systems, Human Interaction speeds, Performance versus Preference, Methods of gaining an understanding of users, Miller's Law. **Design Guidelines:** Navigating the interface, Organizing the display, Getting user's attention, Facilitating data entry. **Principles:** Determine user's skill level, Identify the tasks, Choose an interaction style, Natural Language, Eight Golden rules of Interface design, Prevent errors, Ensuring

Human control while increasing automation. **Theories:** Design-by-level, Stages of action, Consistency, Contextual Theories, Dynamic theories.

#Exemplar/Case Studies	Registration form design.
*Mapping of Course Outcomes for Unit II	CO1,CO2

Unit III	Interaction Styles and HCI in Software Process	07 Hours
-----------------	---	-----------------

Design, Process of Interaction Design. **Interaction styles:** Command line, Menu Selection, Form fill-in, Direct Manipulation. **Graphical User Interface:** Popularity of Graphics, Concept of direct manipulation, Advantages, Disadvantages and characteristics of Graphical user interface. **Web User Interface:** Popularity and Characteristics, Merging of Graphical business systems and the Web- Characteristics of Intranet versus Internet, Web page versus application design, Principles for user interface design, Software life cycle, Usability Engineering, Iterative design and prototyping, Design Rationale.

#Exemplar/Case Studies	Comparison - GUI and Web design with a real time example.
*Mapping of Course Outcomes for Unit III	CO1,CO3,CO5

Unit IV	Usability Evaluation and Universal Design	07 Hours
----------------	--	-----------------

User interface design process: Designing for People: Seven commandments, Usability Assessment in the Design process, Common Usability problems, Practical and Objective measures of Usability, Formative and Summative evaluation, Usability specifications for evaluation, Analytic methods, Model based analysis, GOMS model, Empirical methods, Field studies, Usability testing in Laboratory, Controlled experiments, Heuristic Evaluation, Cognitive Walkthrough.

Evaluation framework: Paradigms and techniques, DECIDE: a framework to guide evaluation, Universal design principles, Multi-modal interaction, Designing for diversity.

#Exemplar/Case Studies	GOMS model - Adding items to a cart of e-shopping website.
*Mapping of Course Outcomes for Unit IV	CO1,CO3

Unit V	HCI Paradigms	07 Hours
---------------	----------------------	-----------------

Paradigms for Interaction: Time sharing, Video display units, Programming toolkits, Personal computing, The metaphor, Direct manipulation, Hypertext, Computer-supported cooperative work, Agent based interfaces. **Ubiquitous Computing:** Sensor-based and context-aware interaction, Data Integrity versus Data immunity, Handling missing data, Data entry and fudge ability, Auditing versus Editing, Retrieval in Physical World, Retrieval in Digital world, Constrained Natural Language output, Five stage search framework, Dynamic queries and faceted search, The social aspects of search.

Pattern Recognition: Introduction, Examples, Role of Machine Learning, Pattern Recognition Process, Pattern Recognition in HCI.

#Exemplar/Case Studies	Interface Design- Pattern gesture recognition
*Mapping of Course Outcomes for Unit V	CO1,CO3,CO4

Unit VI	HCI for Mobile and Handheld devices	07 Hours
----------------	--	-----------------

Designing for Mobile and other devices: Anatomy of a Mobile app, Mobile form factors, Handheld format apps, Tablet format apps, Mini-tablet format apps, Mobile Navigation, Content, and control idioms- browse controls, Navigation and toolbars, Drawers, Tap-to-reveal and direct manipulation, Searching, Sorting and Filtering, Welcome and help screens, Multi-touch gestures, Inter-app integration, Android Accessibility Guidelines.

Other devices: Designing for kiosks, Designing for 10-foot interfaces, Designing for automotive

interfaces, Designing for audible interfaces.

#Exemplar/Case Studies	GUI in Python Enlist and evaluate handled devices
*Mapping of Course Outcomes for Unit VI	CO3,CO5,CO6
Learning Resources	

Text Books:

1. Alan J. Dix. Janet Finlay, Russel Beale, "Human Computer Interaction", Pearson Education, 3rd Edition, 2004, ISBN 81-297-0409-9
2. Jenny Preece, Rogers, Sharp, "Interaction Design-beyond human-computer interaction", WILEY-INDIA, ISBN 81-265-0393-9
3. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, "Designing the User Interface: Strategies for Effective Human- Computer Interaction", 6th Edition, Pearson Education Limited, ISBN 987-1-292-03701-1.

Reference Books :

1. Alan Cooper, Robert Reiman, David Cronin, Christopher Noessel, "About Face: The Essentials of Interaction Design", 4th edition, WILEY, ISBN 978-1-118-76658-3
2. Mary Beth Rosson and John M. Carroll, "Usability Engineering: Scenario-Based Development of Human-Computer Interaction", Morgan Kaufmann Publishers, ISBN 978-1-558-60712-5
3. Wibert O. Galitz, "The Essential Guide to user Interface Design", WILEY India, ISBN: 978-1-265-0280-6
4. Jenifer Tidwell, "Designing Interfaces", O'REILLY, ISBN: 978-1-449-37970-4
5. Julie A. Jacko (Ed), "The Human-Computer Interaction Handbook", 3rd edition, CRC Press, 2012
6. Zou J., Nagy G. (2006) "Human-Computer Interaction for Complex Pattern Recognition Problems"
7. Basu M., Ho T.K. (eds) "Data Complexity in Pattern Recognition. Advanced Information and Knowledge Processing", Springer, London

e-Books :

- http://www.37steps.com/data/pdf/PRIntro_medium.pdf
- https://www.ecse.rpi.edu/~nagy/PDF_chrono/2005_Zou_Nagy_complexity_05.pdf
- <https://www.raywenderlich.com/240-android-accessibility-tutorial-getting-started>

MOOCs Courses link

- <https://www.edx.org/course/human-computer-interaction-i-fundamentals-design-p>
- <https://www.edx.org/course/human-computer-interaction-ii-cognition-context-cu>

@ The CO-PO Mapping Matrix

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

Savitribai Phule Pune University**Third Year of Artificial Intelligence and Data Science (2019 Course)****317523: Software Laboratory I**

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

Prerequisite Courses, if any: Fundamentals of Data Structures (210242), Data Structures and Algorithms (210253)

Companion Course, if any: Artificial Intelligence (310253), Database Management Systems (310241)

Course Objectives:

- To learn and apply various search strategies for AI
- To Formalize and implement constraints in search problems
- To develop basic Database manipulation skills
- To develop skills to handle NoSQL database
- To learn understand to develop application using SQL or NoSQL databases.

Course Outcomes:

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

CO1: Implement SQL queries for given requirements, using different SQL concepts

CO2: Implement NoSQL queries using MongoDB

CO3: Design and develop application using database considering specific requirements

CO4: Design a system using different informed search / uninformed search or heuristic approaches

CO5: Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.

CO6: Design and develop an interactive AI application

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, conducton and Assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software and Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments are to be submitted as softcopy. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal must be avoided. Use of DVD containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory.

Guidelines for Laboratory /Term Work Assessment

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

Guidelines for Practical Examination

Problem statements must be decided 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 AI & DS branch beyond the scope of the syllabus.

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

List of Assignments

**Group A (DBMS) Perform 6 assignment
(Any 5 Assignments from 1 - 6. Assignment 7 is compulsory)**

1. SQL Queries:

- Design and Develop SQL DDL statements which demonstrate the use of SQL objects such as Table, View, Index, Sequence, Synonym, different constraints etc.
- Write at least 10 SQL queries on the suitable database application using SQL DML statements.

Note: Instructor will design the queries which demonstrate the use of concepts like Insert, Select, Update, Delete with operators, functions, and set operator etc.

2. SQL Queries – all types of Join, Sub-Query and View:

Write at least 10 SQL queries for suitable database application using SQL DML statements. Note: Instructor will design the queries which demonstrate the use of concepts like all types of Join ,Sub-Query and View

3. MongoDB Queries:

Design and Develop MongoDB Queries using CRUD operations. (Use CRUD operations, SAVE method, logical operators etc.).

4. Unnamed PL/SQLcode block: Use of Control structure and Exception handling is mandatory.

Suggested Problem statement:

Consider Tables:

1. Borrower (Roll_no, Name, Date_of_Issue, Name_of_Book, Status)
2. Fine (Roll_no, Date, Amt)

- Accept Roll_no and Name_of_Book from user.
- Check the number of days (from Date_of_Issue).
- If days are between 15 to 30 then fine amount will be Rs 5 per day.
- If no. of days > 30, per day fine will be Rs 50 per day and 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.
- Also handles the exception by named exception handler or user define exception handler.

OR

- MongoDB – Aggregation and Indexing: Design and Develop MongoDB Queries using aggregation and indexing with suitable example using MongoDB.
- MongoDB – Map-reduce operations: Implement Map-reduce operation with suitable example using MongoDB.

5. Exporting and Importing data

- Design and develop SQL DML statements to demonstrate **exporting** tables to external files of different file formats ex. CSV, XLSX, TXT, etc.
- Design and develop SQL DML statements to demonstrate **importing** data from external files of different file formats ex. CSV, XLSX, TXT, etc.

6. Cursors: (All types: Implicit, Explicit, Cursor FOR Loop, Parameterized Cursor)

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_Roll_Call. If the data in the first table already exists in the second table then that data should be skipped.

Note: Instructor will frame the problem statement for writing PL/SQL block using all types of Cursors in line with above statement.

7. Database Connectivity:

Write a program to implement MySQL/Oracle database connectivity with any front end language to implement Database navigation operations (add, delete, edit etc.)

Group B (Artificial Intelligence) Perform 6 assignment**(Any 5 Assignments from 1 - 6. Assignment 7 is compulsory)**

1. Implement depth first search algorithm and Breadth First Search algorithm. Use an undirected graph and develop a recursive algorithm for searching all the vertices of a graph or tree data structure.
2. Implement A star (A*) Algorithm for any game search problem.
3. Implement Alpha-Beta Tree search for any game search problem.
4. Implement a solution for a Constraint Satisfaction Problem using Branch and Bound and Backtracking for n-queens problem or a graph coloring problem.
5. Implement Greedy search algorithm for any of the following application:
 - Selection Sort
 - Minimum Spanning Tree
 - Single-Source Shortest Path Problem
 - Job Scheduling Problem
 - Prim's Minimal Spanning Tree Algorithm
 - Kruskal's Minimal Spanning Tree Algorithm
 - Dijkstra's Minimal Spanning Tree Algorithm
6. Develop an elementary chatbot for any suitable customer interaction application.
7. Mini Project: Implement any one of the following Expert System
 - Information management
 - Hospitals and medical facilities
 - Help desks management
 - Employee performance evaluation
 - Stock market trading
 - Airline scheduling and cargo schedules

Group C [DBMS] Mini Project

Develop an application with following details:

1. Follow the same problem statement decided in Assignment-1 of Group A.
2. Follow the Software Development Life cycle and other concepts learnt in **Software Engineering Course** throughout the implementation.
3. Develop application considering:
 - Front End: Python/Java/PHP/Perl/Ruby/.NET/ or any other language
 - Backend : MongoDB/ MySQL/ Oracle / or any standard SQL / NoSQL database
4. Test and validate application using Manual/Automation testing.
5. Student should develop application in group of 2-3 students and submit the Project Report which will consist of documentation related to different phases of Software Development Life Cycle:
 - Title of the Project, Abstract, Introduction
 - Software Requirement Specification (SRS)
 - Conceptual Design using ER features, Relational Model in appropriate Normalize form
 - Graphical User Interface, Source Code
 - Testing document
 - Conclusion.

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

Learning Resources

Text Books:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third edition, Pearson, 2003, ISBN :10: 0136042597
2. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education(India), 2013, ISBN : 978-1-25-902998-1
3. Elaine Rich, Kevin Knight and Nair, "Artificial Intelligence", TMH, ISBN - 978-0-07-008770-5
4. SilberschatzA.,KorthH.,SudarshanS.,"DatabaseSystemConcepts",McGrawHillPublishers,ISBN 0-07-120413-X, 6th edition
5. ConnallyT,BeggC., "DatabaseSystems", Pearson Education,ISBN 81-7808-861-4
6. PramodJ.SadalageandMartinFowler,"NoSQLDistilled",AddisonWesley,ISBN-10:0321826620, ISBN-13: 978-0321826626

Reference Books:

1. Nilsson Nils J , "Artificial Intelligence: A new Synthesis", Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4
2. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley Publishing Company, ISBN: 0-201-53377-4Andries P. Engelbrecht, "Computational Intelligence: An Introduction", 2nd Edition-Wiley India-ISBN: 978-0-470-51250-0
3. Kristina Chodorow, Michael Dierolf, "MongoDB: The Definitive Guide", O'ReillyPublications,ISBN: 978-1-449-34468-9
4. AdamFowler,"NoSQLForDummies",JohnWiley&Sons,ISBN-1118905628
5. Kevin Roebuck, "Storing and Managing Big Data - NoSQL, HADOOP and More",EmereoptyLimited, ISBN: 1743045743, 9781743045749
6. JoyA.Kreibich,"UsingSQLite",O'REILLY, ISBN:13:978-93-5110-934-1
7. SeemaAcharya,"DemystifyingNoSQL",WileyPublications,ISBN:9788126579969

e-Books:

<http://vlabs.iitb.ac.in/vlabs-dev/labs/dblab/labs/index.php>

MOOC Courses:

<http://www.nptelvideos.com/lecture.php?id=6518>

@The CO-PO mapping table

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

Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317524: CN Laboratory

Teaching Scheme:	Credit	Examination Scheme:
PR: 02 Hours/Week	01	Term Work (TW): 25 Marks Practical(PR): 25 Marks

Prerequisite Courses, if any:**Companion Course, if any: Computer Network(317522)****Course Objectives:**

1. To learn computer network hardware and software components
2. To learn computer network topologies and types of network
3. To develop an understanding of various protocols, modern technologies and applications
4. To learn modern tools for network traffic analysis
5. To learn network programming

Course Outcomes:

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

CO1: Analyze the requirements of network types, topology and transmission media**CO2:** Demonstrate error control, flow control techniques and protocols and analyze them**CO3:** Demonstrate the subnet formation with IP allocation mechanism and apply various routing algorithms**CO4:** Develop Client-Server architectures and prototypes**CO5:** Implement web applications and services using application layer protocols**List of Assignments****Group A (Any four assignment)**

1. Demonstrate the different types of topologies and types of transmission media by using a packet tracer tool.
2. Setup a wired LAN using Layer 2 Switch. It includes preparation of cable, testing of cable using line tester, configuration machine using IP addresses, testing using PING utility and demonstrating the PING packets captured traces using Wireshark Packet Analyzer Tool.
3. Setup a WAN which contains wired as well as wireless LAN by using a packet tracer tool. Demonstrate transfer of a packet from LAN 1 (wired LAN) to LAN2 (Wireless LAN).
4. Use packet Tracer tool for configuration of 3 router networks using one of the following protocols RIP/OSPF/BGP.
5. Write a program to demonstrate Sub-netting and find subnet masks.
6. Write a program to implement link state /Distance vector routing protocol to find a suitable path for transmission.

Group B (any six)

7. Socket Programming using C/C++/Java.
 - a. TCP Client, TCP Server
 - b. UDP Client, UDP Serve

8. Write a program using TCP socket for wired network for following
- Say Hello to Each other
 - File transfer
9. Write a program using UDP Sockets to enable file transfer (Script, Text, Audio and Video one file each) between two machines.
10. Capture packets using Wireshark and accomplish the following and save the output in file:
- Capture all TCP traffic to/from Facebook, during the time when you log in to your Facebook account
 - Capture all HTTP traffic to/from Facebook (other website), when you log in to your Facebook account
 - Write a DISPLAY filter expression to count all TCP packets (captured under item #1) that have the flags SYN, PSH, and RST set. Show the fraction of packets that had each flag set.
 - Count how many TCP packets you received from / sent to Facebook (other website), and how many of each were also HTTP packets.
11. Study and Analyze the performance of HTTP, HTTPS and FTP protocol using Packet tracer tool.
12. To study the SSL protocol by capturing the packets using Wireshark tool while visiting any SSL secured website (banking, e-commerce etc.).
13. Illustrate the steps for implementation of S/MIME email security, POP3 through Microsoft® Office Outlook.
14. To study the IPsec (ESP and AH) protocol by capturing the packets using Wireshark tool.

Group C (Compulsory)

15. Installing and configuring DHCP server and assign IP addresses to client machines using DHCP server.
16. Write a program for DNS lookup. Given an IP address input, it should return URL and vice versa.

@The CO-PO mapping table

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



Savitribai Phule Pune University

Third Year of Artificial Intelligence and Data Science (2019 Course)

317525:Elective I Laboratory Embedded Systems and Security

Teaching Scheme:	Credit	Examination Scheme:
PR: 02 Hours/Week	01	Term Work (TW): 25 Marks Oral(OR): 25 Marks

Prerequisite Courses: (217531) Internet of Things laboratory

Companion Course: 317522(A) Embedded Systems and Security

Course Objectives: To prepare students for ‘Embedded Software Engineering’ career

Course Outcomes:

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

CO1: Design Embedded firmware using Embedded C

CO2: Apply the fundamentals of RTOS to design Embedded Systems

CO3: Build the Embedded Linux based Embedded System

Instruction:

1. Practical's can be performed on a suitable ARM based development Board.
2. Perform total 8 experiments; Group A: All; Group B: Any two, Group C: Any two

List of Assignments

Group A

1. To display hexadecimal count with delay on 8 LED's interfaced to GPIO pins of ARM
2. To interface 16x2 LCD to ARM Microcontroller
3. To Program on chip ADC of ARM & display the values on hyperterminal
4. To generate the waveform using on chip DAC of ARM Microcontroller

Group B (Any Two)

5. To port ucos-II on the ARM controller & implement any task
6. To port Embedded Linux on ARM controller & implement any task
7. To load and remove device driver from Kernel

Group C (Any Two)

8. To Implement multitasking with ucos-II on ARM controller
9. To implement semaphore with ucos –II for resource management and synchronization
10. To implement mailbox for message passing between two tasks
11. To write device driver with Embedded Linux

Learning Resources

Text Books:

1. Introduction to Embedded Systems, Shibu K V, MHE India
2. Embedded Systems: An Integrated Approach, Lyla Das, Pearson

Reference Books:

1. Raj Kamal, Embedded Systems – Architecture, Programming and Design, 2nd edition, TMH
2. Jean J. Labrosse, MicroC OS II, The Real-Time Kernel, 2nd edition, CMP Books
3. Chris Simmonds, Mastering Embedded Linux Programming, 2nd edition, Packt Publishing

e-Books:

- <https://bootlin.com/doc/training/embedded-linux/embedded-linux-slides.pdf>
- <https://tec.gov.in/pdf/Studypaper/Embedded%20sytem%20security.pdf>

MOOC Courses:

- Embedded System Design With ARM, By Prof. Indranil Sengupta, Prof. Kamalika Dutta, IIT Kharagpur

@The CO-PO mapping table

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

Savitribai Phule Pune University**Third Year of Artificial Intelligence and Data Science (2019 Course)****317525: Elective I Laboratory Design Thinking**

Teaching Scheme:	Credit	Examination Scheme:
PR: 02 Hours/Week	01	Term Work (TW): 25 Marks Oral(OR): 25 Marks

Prerequisite Courses: Programming and Problem Solving, Software Engineering**Companion Course: 317522(B) Design Thinking****Course Objectives:**

- To identify the opportunities and challenges for design thinking innovation and empathize And ideate for it.
- To describe the solution by prototyping the design

Course Outcomes:

On completion of the course, students will be able to—

- CO1: Frame and Design Challenge by performing STEEP Analysis, Conduct Interviews, design and ask 5x Why and 5W+H questions.
- CO2: Demonstrate the activities to empathize with the users by creation of Empathy Map, Persona Development, Customer Journey Map.
- CO3: Define and ideate process of design thinking and perform brainstorming, selection of ideas, create a storyboard and design paper prototyping or digital prototyping for chosen design challenge.

Guidelines for Lab Conduction

1. Students should be asked to form a group of 3 to 4 students and identify design challenge to provide the solution to real life engineering problems within the social, environmental and economic context.
2. All the assignments should be conducted using the templates provided in the reference books.
3. The faculty member should help student to identify Online free or open source tools like diagrams.net, LucidChart, Draw.io, Creatly, Openboard, Microsoft whiteboard etc. which will help students to collaborate and draw diagram.
4. After every assignment, student group should be asked to demonstrate their design and discuss findings.

List of Assignments (All Compulsory)**Group A**

1. Inspiration Phase: Perform STEEP analysis by using MAKING SENSE OF STEEP ANALYSIS & STRATEGIC PRIORITIES TEMPLATE and Frame Your Design Challenge. Conduct Interviews, design and ask 5x Why and 5W+H questions
2. Empathize Phase: Observe the user and design Empathy Map, Generate persona/User profile and Customer Journey map

Group B

3. Define and Ideate: Share Stories and learning from research- Cluster Insights into themes, Create Insights statements, create ‘How might we’ questions
4. Prototype Phase: Brainstorm, select your ideas, create a storyboard, determine what to prototype, start prototyping, Design Paper Prototype/digital Prototype, test your prototype and get feedback, Create your Action plan, create pitch, share yoursolution, perform reflection

Group C

5. Study and present any two case studies of Design thinking from <https://www.design-thinking-association.org/explore-design-thinking-topics/external-links/design-thinking-case-study-index>
or
Refer any white Papers available on Internet for case study on design Thinking

Learning Resources

Text Books:

1. Michael Lewrick, Patrick Link, Larry Leifer , “The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods”, March 2020 edition, ISBN: 978-1-119-62921-4, WILEY Publication.
2. Mr Lee Chong Hwa (Lead Facilitator), “The Design Thinking: Guidebook”

Reference Books:

1. IDEO (Firm), “The Field Guide to Human-centered Design: Design Kit”, 1 st edition, ISBN978099140631-9, IDEO 2015.
2. Jeanne Liedtka, Tim Ogilvie, and Rachel Brozenske, The Designing for Growth Field Book: A Step-by-Step Project Guide (Columbia University Press, 2014)

e-Books:

1. Design Thinking , A guide to Creative problem Solving for Everyone. Andy Pressman <https://1lib.in/book/3656420/e95cd0>
2. The Design thinking Playbook: Mindful Digital Transformation of Teams, Products , Services, Businesses and Ecosystems , Michael Lewrick <https://1lib.in/book/3603473/24dab2>

MOOC Courses:

- <https://nptel.ac.in/courses/110106124>
- <https://www.simplilearn.com/learn-design-thinking-basics-free-course-skillup>

@The CO-PO mapping table

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

Savitribai Phule Pune University

Third Year of Artificial Intelligence and Data Science (2019 Course)

317525: Elective I Laboratory Pattern Recognition

Teaching Scheme:	Credit	Examination Scheme:
PR:02 Hours/Week	01	Term Work (TW): 25 Marks Oral(OR): 25 Marks

Prerequisite Course: Basics of Automata Theory

Companion Course:317522(C): Pattern Recognition

Course Objectives:

- To understand fundamentals of pattern recognition.
- To Study syntactic approach in pattern recognition.
- To study statistical approaches in pattern recognition.
- To study artificial neural network-based pattern recognition

Course Outcomes:

On completion of the course, learner will be able to

CO1: Apply statistical pattern recognition approaches.

CO2: Implement different approaches of syntactic pattern recognition.

CO3: Develop artificial neural network-based pattern recognition system

List of Assignments (All Compulsory)

Group A

- Use Bayesian Decision theory of statistical pattern recognition to classify the object
- Implement Cocke–Younger–Kasami (CYK) Parsing Algorithm using Syntactic Pattern Recognition

Group B

- Generate a Pattern from String using syntactical Pattern Approach
- Apply suitable pattern recognition technique to perform Character Recognition

Group C

- Develop a system for Handwritten Digit Recognition using Neural Network

Learning Resources

Text Books:

1. ROBBERT SCHALKOFF, “Pattern Recognition: Statistical, Structural and Neural Approaches”, Wiley Publication, ISBN978-81-245-1370-3
2. R.O.Duda, P.E.Hart and D.G.Stork, “Pattern Classification”, John wiley ISBN-978-0-471-05669-0

Reference Books:

1. Earl Gose, Richard Johnsonbaugh, Steve Jost, “Pattern Recognition and Image Analysis”
2. Andrew R.Webb, Keith D.Copsey,”Statistical Pattern Recognition”,3rd edition Wiely , ISBN:978-0-470-68227-2
3. Christopher M. Bishop,”Neural network for Pattern Recognition,” Oxford University Press, ISBN-978-0-19-853864-6

e-Books:

- <http://users.isr.ist.utl.pt/~wurmd/Livros/school/Bishop%20%20Pattern%20Recognition%20And%20Machine%20Learning%20-%20Springer%20%202006.pdf>
- [https://darmanto.akacom.ac.id/pengenalanpola/Pattern%20Recognition%204th%20Ed.%20\(2009\).pdf](https://darmanto.akacom.ac.id/pengenalanpola/Pattern%20Recognition%204th%20Ed.%20(2009).pdf)
- https://www.inf.ed.ac.uk/teaching/courses/nlu/assets/reading/Gurney_et_al.pdf

MOOC Courses:

- <https://nptel.ac.in/courses/117105101>
- <https://nptel.ac.in/courses/106106046>

@The CO-PO mapping table

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

Savitribai Phule Pune University**Third Year of Artificial Intelligence and Data Science (2019 Course)****317525: Elective I Laboratory Human Computer Interface****Teaching Scheme:****Credit****Examination Scheme:****PR:02 Hours/Week****01****Term Work (TW): 25 Marks****Oral(OR): 25 Marks****Prerequisite Courses, if any:** Computer Graphics , Software Engineering**Companion Course, if any: Human Computer Interface (317522(D)):****Course Objectives:**

- To understand the importance of HCI design process in software development
- To learn fundamental aspects of designing and implementing user interfaces
- To study HCI with technical, cognitive and functional perspectives
- To acquire knowledge about variety of effective human-computer-interactions
- To co-evaluate the technology with respect to adapting changing user requirements in interacting with computer

Course Outcomes:

On completion of the course, learner will be able to

- **CO1:** To design effective Human-Computer-Interfaces for all kinds of users
- **CO2:** To apply and analyze the user-interface with respect to golden rules of interface
- **CO3:** To implement the interactive designs for feasible data search and retrieval

List of Assignments (All Compulsory)**Group A**

- List five technologies from the Knowledge Navigator video that were not around in 1987, but are in widespread use today
- Implement GOMS (Goals, Operators, Methods and Selection rules) modelling technique to model user's behavior in given scenario

Group B

- Using your observations from your small user study and your knowledge of Web Design guidelines and general UI design principles, Critique two interfaces of any two educational institute and make suggestions for improvement.
- Implement a simple interactive webpage, showing a tabbed UI (which is implemented not through widgets but by interacting with and controlling the Document Object Model with JavaScript and CSS). This page consists of a centered container with 3 tabs each for showing a text, an image and a youtube video. A div containing three Buttons is used as a tab bar and pressing each button displays the corresponding tab. Only one tab should be displayed at a time. The button showing the current tab must remain highlighted from the moment your page is loaded.

Group C

- Develop interactive user interfaces using Javascript, CSS and HTML, specifically: a. implementation of form-based data entry, input groups, and button elements using the Bootstrap library. b. use of responsive web design (RWD) principles, c. implementing JavaScript communication between the input forms and a custom visualization component
- Make a Table Lamp in Blender – A 3 D modeling software

Learning Resources

Text Books:

1. Alan J. Dix, Janet Finlay, Russell Beale, "Human Computer Interaction", Pearson Education, 3rd Edition, 2004, ISBN 81-297-0409-9.
2. Jenny Preece, Rogers, Sharp, "Interaction Design-beyond human-computer interaction", WILEY-INDIA, ISBN 81-265-0393-9.
3. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, "Designing the User Interface: Strategies for Effective Human- Computer Interaction", 6th Edition, Pearson Education Limited. ISBN 987-1-292-03701-1.

• Reference Books:

1. Alan Cooper, Robert Reiman, David Cronin, Christopher Noessel, "About Face: The Essentials of Interaction Design", 4 th edition, WILEY, ISBN 978-1-118-76658-3
2. Mary Beth Rosson and John M. Carroll, "Usability Engineering: Scenario-Based Development of Human-Computer Interaction", Morgan Kaufmann Publishers, ISBN 978-1- 558-60712-5
3. Wibert O. Galitz, "The Essential Guide to user Interface Design", WILEY India, ISBN: 978- 1-265-0280-6.
4. Jenifer Tidwell, "Designing Interfaces", O'REILLY, ISBN: 978-1-449-37970-4.
5. Julie A. Jacko (Ed), "The Human-Computer Interaction Handbook", 3rd edition, CRC Press, 2012.
6. Zou J., Nagy G. (2006) "Human-Computer Interaction for Complex Pattern Recognition Problems".
7. Basu M., Ho T.K. (eds) "Data Complexity in Pattern Recognition. Advanced Information and Knowledge Processing", Springer, London.

e-Books

- http://www.37steps.com/data/pdf/PRIntro_medium.pdf
- https://www.ecse.rpi.edu/~nagy/PDF_chrono/2005_Zou_Nagy_complexity_05.pdf
- <https://www.raywenderlich.com/240-android-accessibility-tutorial-getting-started>

MOOC Courses:

- <https://www.edx.org/course/human-computer-interaction-i-fundamentals-design-p>
- <https://www.edx.org/course/human-computer-interaction-ii-cognition-context-cu>

@The CO-PO mapping table

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

Savitribai Phule Pune University**Third Year of Artificial Intelligence and Data Science (2019 Course)****317526: Seminar and Technical Communication**[Home](#)**Teaching Scheme****Credit: 01****Examination Scheme and Marks****Tutorial: 01 Hour/Week****Term Work: 25 Marks****Course Objectives:**

- To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques
- To explore the latest technologies
- To enhance the communication skills
- To develop problem analysis skills

Course Outcomes:

On completion of the course, learners will be able to

CO1: Analysis specialized topic of interest from core area

CO2: Enhance Technical writing skills

CO3: Targeting specific problem and indentify working solution to resolve it.

CO4: Developing professional communication skill

Guidelines

- Each student will select a topic in the area of Computer Engineering and Technology preferably keeping track with recent technological trends and development beyond scope of syllabus avoiding repetition in consecutive years.
- The topic must be selected in consultation with the Institute guide.
- **All the assignments mentioned below are mandatory**
- Each student will make a seminar presentation using audio/visual aids for a duration of 20-25 minutes and submit the seminar report prepared in Latex only.
- Active participation at classmate seminars is essential.
- BoS has circulated the Seminar Log book and it is recommended to use it.

Guidelines for Assessment

Panel of staff members along with a guide would be assessing the seminar work based on these parameters-Topic, Contents and Presentation, regularity, Punctuality and Timely Completion, Question and Answers, Report, Paper presentation/Publication, Attendance and Active Participation.

Recommended Format of the Seminar Report

- Title Page with Title of the topic, Name of the candidate with Exam Seat Number / Roll Number, Name of the Guide, Name of the Department, Institution and Year and University
- Seminar Approval Sheet/Certificate,
- Abstract and Keywords
- Acknowledgements
- Table of Contents, List of Figures, List of Tables and Nomenclature
- Chapters Covering topic of discussion- Introduction with section including organization of the report, Literature Survey/Details of design/technology/Analytical and/or experimental work, if any/.....,Discussions and Conclusions ,Bibliography/References
- Plagiarism Check report
- Report Documentation page

List of Assignments

1. Assignment on selecting technical topic from computer domain; this assignment should include importance of the topic, its impact and future scope.

2. Assignment on analyzing the latest technical topic through literature survey; this assignment may include progress of the topic from last few years like contents from review reports, journals or research papers related to selected topic for seminar work. Students should keep records of all the resources and use citation.
3. Analyze the topic and prepare technical details of the selected topic. This assignment may include contents like architecture details, different modules in detail, algorithms, and hardware details if any.

Reference Books :

1. Rebecca Stott, Cordelia Bryan, Tory Young, "Speaking Your Mind: Oral Presentation and Seminar Skills (Speak-Write Series)", Longman, ISBN-13: 978-0582382435
2. Johnson-Sheehan, Richard, "Technical Communication", Longman. ISBN 0-321-11764-6
3. Vikas Shirodka, "Fundamental skills for building Professionals", SPD, ISBN 978-93-5213-146-5

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317527: Environmental Studies

Teaching Scheme:	Credit	Examination Scheme:
Tut: 01 Hours/Week	01	Term Work(TW): 25 Marks

Prerequisite Courses, if any: Multidisciplinary nature of environmental studies; components of environment – atmosphere, hydrosphere, lithosphere and biosphere.

Companion Course, if any:

Preamble:

An environmental study is a multidisciplinary academic field which systematically studies human interaction with the environment. Environmental studies connect principles from the physical sciences, commerce/economics, the humanities, and social sciences to address complex contemporary environmental issues. Imparting basic knowledge about the environment and its allied problems. Developing an attitude of concern for the environment.

Course Objectives:

- To gain an understanding of the Environment where we live
- Understanding the importance of water
- To educate about Air and Noise pollution
- To explain the concepts of E-waste and Green Computing

Course Outcomes:

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

CO1: Aware the importance of environment

CO2: Understand the water pollution

CO3: Know the Air and noise pollution

CO4: Understand the E-waste and green computing

Course Contents

Unit I	Introduction to Environmental Pollution	(03 Hours)
---------------	--	-------------------

Environmental pollution: Environment and its importance, Definition, Types. Effect of environmental pollution on Plants, Non-living things.

Unit II	Water Pollution	(03 Hours)
----------------	------------------------	--------------------

Water Pollution: Definition, Sources of water Pollution, Types of wastewater-Domestic and industrial wastewater

Unit III	Air Pollution and Noise Pollution	(03 Hours)
-----------------	--	-------------------

Air pollution: Definition, Sources/causes of air pollution. Atmospheric layers, Effects on human.

Noise Pollution: Definition of Noise Pollution, Types of Noise Pollution

Unit IV	E-waste Management and Green computing	(03 Hours)
----------------	---	-------------------

E-waste management: Definition of E-waste, Sources of E-waste, Types of E-waste

Green computing: Definition, Objectives of Green Computing, Necessity, Environmental benefits

Tutorial Conduction and Term work Guidelines (Set of Suggested Activities)

The students are expected to submit

- 1) Report/Presentation on the effect of Environmental Pollution on any world famous Structure/monument.
- 2) Report/Presentation on importance of different sources of water available nearby them.
- 3) Report/Presentation based on the data collected from the local authorities on air pollution and noise pollution.
- 4) Report/Presentation on the E-Waste generated in the campus.

Learning Resources

Text Books:

3. "The text book of Environmental studies", Dr. P. D. Raut, Shivaji University, 2013.
4. "A Text Book of Environmental Studies", Dr. D. K. Asthana, S. Chand.
5. "Environmental Pollution, monitoring and control", S. M. Khopkar, New Age Publication.

Reference Books:

4. "Air Pollution", M. N. Rao, McGrawHill, Publication.
5. "E-waste Management and Procurement of Environment", Dr. Suresh Kumar, Authorspress, 2021.
6. "Green Computing Approach towards sustainable development", M. Afshar Alam, Dreamtech Press. 2020.

Web Links:

1. Prof. Mukesh Sharma, IIT Kanpur <https://archive.nptel.ac.in/courses/105/102/105102089>
2. Prof. J. Bhattacharyya, IIT Kharagpur, <https://archive.nptel.ac.in/courses/123/105/123105001>
3. Prof. Bhola Ram Gurjar, IIT Roorkee, <https://archive.nptel.ac.in/courses/105/107/105107213>

- e-Books:**
1. Bharucha, Erach (2005): "Text Book of Environmental Studies for Undergraduate Courses", University Press (India) pvt ltd, Hyderabad, India
 2. Kothari Dr Milind- 2005- Environmental Education- Universal Publication Agra.
 3. IGNOU 1995- FST- 1/4 Foundation course in Science and Technology "Environment and Resource" – Indira Gandhi Open University, New Delhi.

MOOC Courses: https://onlinecourses.swayam2.ac.in/cec21_ge21/preview

@The CO-PO mapping table

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

SavitribaiPhule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317528(A): Audit Course5
AC5-A: Emotional Intelligence


Course Objectives:

- To develop an awareness of Emotional Intelligence models
- To recognize the benefits of Emotional Intelligence
- To understand how to use emotion to facilitate thought and behavior
- To know and utilize the difference between reaction and considered response

Course Outcomes:

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

- CO1:** Expand their knowledge of emotional patterns in themselves and others
- CO2:** Discover how to manage their emotions, and positively influence themselves and others
- CO3:** Build more effective relationships with people at work and home
- CO4:** Positively influence and motivate colleagues, team members and managers
- CO5:** Increase their leadership effectiveness by creating an atmosphere that engages others

Course Contents

- 1. Introduction to Emotional Intelligence (EI) :** Emotional Intelligence and various EI models, The EQ competencies of self-awareness, self-regulation, motivation, empathy, and interpersonal skills, Understand EQ and its importance in life and the workplace
- 2. Know and manage your emotions:** Emotions, Different levels of emotional awareness, Increase emotional knowledge of yourself, Recognize ‘negative’ and ‘positive’ emotions, The relationship between emotions, thought and behavior, Discover the importance of values, The impact of not managing and processing ‘negative’ emotions, Techniques to manage your emotions in challenging situations
- 3. Recognize emotions in others :** The universality of emotional expression, Learn tools to enhance your ability to recognize and appropriately respond to others' emotions, Perceiving emotions accurately in others to build empathy
- 4. Relate to others:** Applying EI in the workplace, the role of empathy and trust in relationships, Increase your ability to create effective working relationships with others (peers, subordinates, managers, clients, Find out how to deal with conflict, Tools to lead, motivate others and create a high performing team.

Learning Resources**Books:**

7. Daniel Goleman,” Emotional Intelligence – Why It Matters More Than IQ,” , Bantam Books, ISBN-10: 055338371X13: 978-0553383713
8. Steven Stein , “The EQ Edge” , Jossey-Bass, ISBN : 978-0-470-68161-9
9. Drew Bird , “The Leader’s Guide to Emotional Intelligence” , ISBN: 9781535176002

@The CO-PO mapping table

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

SavitribaiPhule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317528(B): Audit Course5
AC5-B: Industrial Safety and Consciousness

Course Objectives:

- To understand industrial hazards and safety requirements with norms
- To learn the basics of safety performance planning
- To know the means of accident prevention
- To understand the impact of industrialization on environment
- To know the diversified industrial requirements of safety and security

Course Outcomes:

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

- CO1: Formulate the plan for safety performance
 CO2: Formulate the action plan for accidents and hazards
 CO3: Follow the safety and security norms in the industry
 CO4: Consider critically the environmental issues of industrialization

Course Contents**1. Introduction**

Elements of safety programming, safety management, upgrading developmental programmers: safety procedures and performance measures, education, training and development in safety.

2. Safety Performance Planning

Safety Performance: An overview of an accident, It is an accident, injury or incident, The safety professional, Occupational health and industrial hygiene, Understanding the risk: Emergency preparedness and response, prevention of accidents involving hazardous substances.

3. Accident Prevention

What is accident prevention, Maintenance and Inspection, Monitoring Techniques, General Accident Prevention, Safety Education and Training

4. Safety Organization

Basic Elements of Organized Safety, Duties of Safety Officer, Safe work Practices, Safety Sampling and Inspection, Job Safety Analysis (JSA), Safety Survey, On-site and Off-site Emergency Plan, Reporting of Accidents and Dangerous Occurrences

5. Environment

Introduction, Work Environment, Remedy, pollution of Marine Environment and Prevention, Basic Environmental Protection Procedures, Protection of Environment in Global Scenario, Greenhouse Gases, Climate Change Impacts, GHG Mitigation Options, Sinks and Barriers

6. Industrial Security(Industry wise)

General security Systems in Factories, Activation Security, Computer Security, Banking Security, V.I.P. Security, Women Security, Event Security, Security in Open Environments

Learning Resources**Books:**

1. Basudev Panda ,“Industrial Safety, Health Environment and Security”,Laxmi Publications, ISBN-10: 9381159432, 13: 978-9381159439
2. L.M. Deshmukh, “Industrial Safety Management”, TMH , ISBN: 9780070617681

@The CO-PO mapping table

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

SavitribaiPhule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317528(C): Audit Course5
AC5-C: 3D Printing

Course Objectives:

- To understand the principle of 3D printing
- To understand resource requirements of 3D printing
- To know the basic artwork needed for 3D printing

Course Outcomes:

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

- CO1: Apply models for 3D printing
 CO2: Plan the resources for 3D printing
 CO3: Apply principles in 3D printing in real world

Course Contents

- Getting started with 3D Printing:** How 3D Printers fit into Modern Manufacturing, Exploring the Types of 3D Printing, Exploring Applications of 3D Printing.
- Outlining 3D Printing Resources:** Identifying Available Materials for 3D Printing, Identifying Available Sources for 3D Printable Objects.
- Exploring the Business Side of 3D Printing:** Commoditizing 3D Printing, Understanding 3D Printing's Effect on Traditional lines of Business, Reviewing 3D Printing Research.
- Employing Personal 3D printing Devices:** Exploring 3D printed Artwork, Considering Consumer level 3D Printers, Deciding on RepRap of Your Own

Learning Resources**Books:**

1. Richard Horne, Kalani Kirk Hausman, “ 3D Printing for Dummies”, Taschenbuch, ISBN: 9781119386315
2. Greg Norton, “3D Printing Business - 3D Printing for Beginners - How to 3D Print”, ISBN:9781514785669
3. Liza Wallach Kloski and Nick Kloski, “ Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution”, Maker Media, ISBN:1680450204
4. Jeff Heldrich , “3D Printing: Tips on Getting Started with 3D Printing to Help you make Passive income for your Business”

@The CO-PO mapping table

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

SavitribaiPhule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317528(D): Audit Course5
AC5-D: Foreign Language(Japanese Module 3)

Prerequisite Courses, if any: We recommend that candidates should have previously completed **AC3-V(217527-V) and AC4-V (217535-V)**

Companion Course, if any:

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 be able to–

- CO1: Have ability of basic communication.
- CO2: Have the knowledge of Japanese script.
- CO3: Get introduced to reading, writing and listening skills for Japanese language.
- CO4: Develop interest to pursue professional Japanese language course.

Course Contents

1. Introduction to Kanji Script, Describing one's daily routine. To ask what someone does. Expressions of Giving and Receiving.
2. Adjectives (Types of adjectives), Asking impression or an opinion about a thing / person / place that the listener has experienced, visited, or met, Describing things / persons / places with the help of the adjectives.
3. Expressions of Like and Dislikes. Expressing one's ability, hobby, Comparison between objects, persons and cities, this resulted from a certain action in the past.

Learning Resources

References:

1. Minna No Nihongo, —Japanese for Everyone, Elementary Main Text book 1-1 (Indian Edition), Goyal Publishers & Distributors Pvt. Ltd.
2. <http://www.tcs.com> (http://www.tcs.com/news_events/press_releases/Pages/TCS-InauguratesJapan-centric-Delivery-Center-Pune.aspx)

@The CO-PO mapping table

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

SavitribaiPhule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317528(E): Audit Course5
AC5-E: MOOC- Learn New Skills


Course Objectives:

- To promote interactive user forums to support community interactions among students, professors, and experts
- To promote students to learn additional skills anytime and anywhere
- To enhance teaching and learning on campus and online
- To motivate students for self-learning useful for advancing their career

Course Outcomes:

CO1: On completion of the course, learner will acquire additional knowledge and skill.

Course Contents

MOOCs (Massive Open Online Courses) provide affordable and flexible way to learn new skills, pursue lifelong interests and deliver quality educational experiences at scale. It helps you to learn for yourself, to advance your career or leverage online courses to educate your workforce. Platforms such as SWAYAM, NPTEL, edx or similar ones can help for self-learning.

World's largest SWAYAM MOOCs is a new paradigm of education for anyone, anywhere, anytime, as per your convenience. It aims to provide digital education free of cost and facilitate hosting of all the interactive courses prepared by more than 1000 specially chosen the best faculty and teachers in the country. SWAYAM MOOCs enhance active learning for improving lifelong learning skills by providing easy access to global resources.

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. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have remained untouched so far by the digital revolution and have not been able to join the mainstream of the knowledge economy.

This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere, at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses.

The courses hosted on SWAYAM is generally in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology. In order to ensure best quality content are produced and delivered, seven National Coordinators have been appointed: They are NPTEL for engineering and UGC for post-graduation education.

Guidelines:

Instructors are requested to promote students to opt for courses (not opted earlier) with proper mentoring. The departments will take care of providing necessary infrastructure and facilities for the learners.

Learning Resources**References:**

1. <https://swayam.gov.in/>
2. <https://onlinecourses.nptel.ac.in/>
3. <https://www.edx.org>

@The CO-PO mapping table

*Mapping will vary according to the course selected.

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												

Semester VI





Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317529: Data Science

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week##	03	Mid_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses, if any: Discrete Mathematics, Database Management Systems

Companion Course, if any: Data Science

Course Objectives:

- To understand the need of Data Science
- To understand computational statistics in Data Science
- To study and understand the different technologies used for Data processing
- To understand and apply data modeling strategies
- To learn Data Analytics using Python programming
- To be conversant with advances in analytics

Course Outcomes:

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

- CO1: Analyze needs and challenges for Data Science
- CO2: Apply statistics for Data Analytics
- CO3: Apply the lifecycle of Data analytics to real world problems
- CO4: Implement Data Analytics using Python programming
- CO5: Implement data visualization using visualization tools in Python programming
- CO6: Design and implement Big Databases using the Hadoop ecosystem

Course Contents

Unit I	Introduction to Data Science	(07 Hours)
Basics and need of Data Science, Applications of Data Science, Relationship between Data Science and Information Science, Business intelligence versus Data Science, Data: Data Types, Data Collection. Need of Data wrangling, Methods: Data Cleaning, Data Integration, Data Reduction, Data Transformation, and Data Discretization.		
#Exemplar/Case Studies	Create academic performance dataset of students and perform data pre-processing using techniques of data cleaning and data transformation.	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	Statistical Inference	(7 Hours)
Need of statistics in Data Science, Measures of Central Tendency: Mean, Median, Mode, Mid-range. Measures of Dispersion: Range, Variance, Mean Deviation, Standard Deviation. Bayes theorem, Basics and need of hypothesis and hypothesis testing, Pearson Correlation, Sample Hypothesis testing, Chi-Square Tests, t-test.		
#Exemplar/Case Studies	For an employee dataset, create a measure of central tendency and its measure of dispersion for statistical analysis of given data.	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	Data Analytics Life Cycle	(7 Hours)
Introduction, Data Analytic Lifecycle: Introduction, Phase 1: Discovery, Phase 2: Data Preparation, Phase 3: Model Planning, Phase 4: Model Building, Phase 5: Communication results, Phase 6: Operationalize.		
#Exemplar/Case Studies	Case study: Global Innovation Social Network and Analysis (GINA).	

Mapping of Course Outcomes for Unit III	CO3			
Unit IV	Predictive Data Analytics with Python (7 Hours)			
Introduction, Essential Python Libraries, Basic examples. Data Preprocessing: Removing Duplicates, Transformation of Data using function or mapping, replacing values, Handling Missing Data. Analytics Types: Predictive, Descriptive and Prescriptive. Association Rules: Apriori Algorithm, FP growth. Regression: Linear Regression, Logistic Regression. Classification: Naïve Bayes, Decision Trees. Introduction to Scikit-learn, Installations, Dataset, matplotlib, filling missing values, Regression and Classification using Scikit-learn.				
#Exemplar/Case Studies	Use IRIS dataset from Scikit and apply data preprocessing methods			
Mapping of Course Outcomes for Unit IV	CO4, CO2			
Unit V	Data Analytics and Model Evaluation (7 Hours)			
Clustering Algorithms: K-Means, Hierarchical Clustering, Time-series analysis. Introduction to Text Analysis: Text-preprocessing, Bag of words, TF-IDF and topics. Need and Introduction to social network analysis, Introduction to business analysis. Model Evaluation and Selection: Metrics for Evaluating Classifier Performance, Holdout Method and Random Sub sampling, Parameter Tuning and Optimization, Result Interpretation, Clustering and Time-series analysis using Scikit- learn, sklearn. metrics, Confusion matrix, AUC-ROC Curves, Elbow plot.				
#Exemplar/Case Studies	Use IRIS dataset from Scikit and apply K-means clustering methods			
Mapping of Course Outcomes for Unit V	CO4, CO2			
Unit VI	Data Visualization and Hadoop (7 Hours)			
Introduction to Data Visualization, Types of data visualization, Data Visualization Techniques, Tools used in Data Visualization, Challenges to Big data visualization, Visualizing Big Data, Analytical techniques used in Big data visualization, Hadoop ecosystem, Map Reduce, Pig, Hive,. Data Visualization using Python: Line plot, Scatter plot, Histogram, Density plot, Box- plot.				
#Exemplar/Case Studies	Use IRIS dataset from Scikit and plot 2D views of the dataset			
Mapping of Course Outcomes for Unit VI	CO5, CO6			
Learning Resources				
Text Books:				
<ol style="list-style-type: none"> 1. David Dietrich, Barry Hiller, "Data Science and Big Data Analytics", EMC education services, Wiley publication, 2012, ISBN0-07-120413-X. 2. Jiawei Han, Micheline Kamber, and Jian Pie, "Data Mining: Concepts and Techniques" Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807. 				
Reference Books:				
<ol style="list-style-type: none"> 1. EMC Education Services, "Data Science and Big Data Analytics- Discovering, analyzing Visualizing and Presenting Data" Ist Edition. 2. DT Editorial Services, "Big Data, Black Book", DT Editorial Services, ISBN: 9789351197577, 2016 Edition. 3. Chirag Shah, "A Hands-On Introduction To Data Science", Cambridge University Press, (2020), ISBN : ISBN 978-1-108-47244-9. 4. Wes McKinney, "Python for Data Analysis ", O' Reilly media, ISBN: 978-1-449-31979-3. 5. Trent Hauk, "Scikit-learn Cookbook", Packt Publishing, ISBN: 9781787286382. 6. Jenny Kim, Benjamin Bengfort, "Data Analytics with Hadoop", O'Reilly Media, Inc., ISBN: 9781491913703 				

- | |
|--|
| <p>7. Venkat Ankam, "Big Data Analytics", Packt Publishing, ISBN: 9781785884696.</p> <p>8. Seema Acharya, Subhashini Chellappan, "Big Data And Analytics", Wiley publication, ISBN: 9788126579518.</p> |
|--|

e-Books:

1. An Introduction to Statistical Learning by Gareth James
<https://www.ime.unicamp.br/~dias/Intoduction%20to%20Statistical%20Learning.pdf>
2. Python Data Science Handbook by Jake VanderPlas
<https://tanhiamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf>
3. Hadoop Tutorial :
https://www.tutorialspoint.com/hadoop/hadoop_tutorial.pdf?utm_source=7_&utm_medium=affiliate&utm_content=5f34cd37cdf1050001b09537&utm_campaign=Admitad&utm_term=761c575424fc4a6b48d02f72157eb578
4. Learning with Python; How to think like a computer scientist:
<http://openbookproject.net/thinkcs/python/english3e/>
5. Scikit Learn Tutorial <https://scikit-learn.org/stable/>
6. Python for everybody:http://d01.dr-chuck.com/pythonlearn/EN_us/pythonlearn.pdf
7. An introduction to data Science :
<https://docs.google.com/file/d/0B6iefdnF22XQeVZDSkxjZ0Z5VUE/edit?pli=1>

MOOC Courses:

MOOCs Courses links:

1. Computer Science and Engineering - NOC:Data Science for Engineers
2. Computer Science and Engineering - NOC:Python for Data Science
3. Computer Science and Engineering - NOC:Data Mining
4. Computer Science and Engineering - NOC:Big Data Computing
5. Big Data Computing - Course

@The CO-PO mapping table

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

Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317530: Cyber Security

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week##	03	Mid_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses, if any: Computer Networks (317521)

Companion Course, if any: Mini Project (317536)

Course Objectives:

- To offer an understanding of principle concepts, central topics and basic approaches in information and cyber security.
- To know the basics of cryptography.
- To acquire knowledge of standard algorithms and protocols employed to provide confidentiality, integrity and authenticity.
- To enhance awareness about Personally Identifiable Information (PII), Information Management, cyber forensics.

Course Outcomes:

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

CO1: Gauge the security protections and limitations provided by today's technology.

CO2: Identify cyber security threats.

CO3: Analyze threats in order to protect or defend it in cyberspace from cyber-attacks.

CO4: Build appropriate security solutions against cyber-attacks

Course Contents

Unit I	Introduction	(06 Hours)
Introduction, Elements of Information Security, Security Policy, Techniques, Steps, Categories, Operational Model of Network Security, Basic Terminologies in Network Security. Threats and Vulnerability, Difference between Security and Privacy.		
#Exemplar/Case Studies	Case study on cyber attacks	
Mapping of Course Outcomes for Unit I	C01, C02	
Unit II	Data Encryption Techniques And Standards	(08 Hours)
Introduction, Encryption Methods: Symmetric, Asymmetric, Cryptography, Substitution Ciphers. Transposition Ciphers, Stenography applications and limitations, Block Ciphers and methods of operations, Feistal Cipher, Data Encryption Standard (DES), Triple DES, Weak Keys in DES Algorithms, Advance Encryption Standard (AES).		
#Exemplar/Case Studies	Symmetric encryption algorithm case study	
Mapping of Course Outcomes for Unit II	C03, C04	
Unit III	Public Key And Management	(08 Hours)
Public Key Cryptography, RSA Algorithm: Working, Key length, Security, Key Distribution, Deffie-Hellman Key Exchange, Elliptic Curve: Arithmetic, Cryptography, Security, Authentication methods, Message Digest, Kerberos, X.509 Authentication service. Digital Signatures: Implementation, Algorithms, Standards (DSS), Authentication Protocol.		
#Exemplar/Case	Public encryption algorithm case study	

Studies		
Mapping of Course Outcomes for Unit III	C03, C04	
Unit IV	Security Requirements	(08 Hours)

IP Security: Introduction, Architecture, IPV6, IPv4, IPSec protocols, and Operations, AH Protocol, ESP Protocol, ISAKMP Protocol, VPN. WEB Security: Introduction, Secure Socket Layer (SSL), SSL Session and Connection, SSL Record Protocol, Change Cipher Spec Protocol, Alert Protocol, Handshake Protocol. Electronic Mail Security: Introduction, Pretty Good Privacy, MIME, S/MIME, Comparison. Secure Electronic Transaction (SET).

#Exemplar/Case Studies	Cisco Security case study	
Mapping of Course Outcomes for Unit IV	C03, C04	
Unit V	Firewall And Intrusion	(08 Hours)

Introduction, Computer Intrusions. Firewall Introduction, Characteristics and types, Benefits and limitations. Firewall architecture, Trusted Systems, Access Control. Intrusion detection, IDS: Need, Methods, Types of IDS, Password Management, Limitations and Challenges.

#Exemplar/Case Studies	Firewall And Intrusion case study	
Mapping of Course Outcomes for Unit V	C03, C04	
Unit VI	Cyber Forensic, Hacking& its countermeasures	(08 Hours)

Personally Identifiable Information (PII), Cyber Stalking, Cybercrime, PII Confidentiality Safeguards, Information Protection Law: Indian Perspective. Hacking: Remote connectivity and VoIP hacking, Wireless Hacking, Mobile Hacking, countermeasures

#Exemplar/Case Studies	Cyber Forensics, ethical hacking case study	
Mapping of Course Outcomes for Unit VI	C03, C04	

Learning Resources

Text Books:

6. Dr. V.K. Pachghare, Cryptography and Information Security, PHI, ISBN 978-81-303-5082-3
7. Nina Godbole,SunitBelapure, Cyber Security,Wiley India, ISBN:978-81-345-2179-1
8. PDF Digital Content : Stuart McCLURE, Joel Scambray, George Kurtz, Hacking Exposed Network Security Secrets and Solutions, McGrawHill, 2012 ISBN: 978-0-07-178028-5
Digital Ref: <http://84.209.254.175/linux-pdf/Hacking-Exposed-7-Network-Security-Secrets.pdf>College libraries are requested to purchase the copy

Reference Books:

10. William Stallings, “Cryptography and Network Security: Principles and Practice”, 7/e, Pearson, ISBN:9789332585225.
https://pearsoned.co.in/web/books/9789332585225_Cryptography-and-Network-Security_William-Stallings.aspx
11. Atul Kahate, “Cryptography and Network Security”, Mc Graw Hill Publication, 2nd Edition, 2008, ISBN : 978-0-07-064823-4

e-Books: <https://www.simplilearn.com/introduction-to-cyber-security-beginners-guide-pdf>

MOOC Courses: https://onlinecourses.swayam2.ac.in/cec20_cs15/preview

@The CO-PO mapping table

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

Savitribai Phule Pune University**Third Year of Artificial Intelligence and Data Science (2019 Course)****317531: Artificial Neural Network****Teaching Scheme:****Credit****Examination Scheme:****TH: 04 Hours/Week##****03****Mid_Semester(TH): 30 Marks****End_Semester(TH): 70 Marks**

Prerequisite Courses, if any: Basic knowledge of computer architecture, Artificial Intelligence and Statistics

Companion Course, if any: NIL

Course Objectives:

1. To provide students with a basic understanding of the fundamentals and applications of artificial neural networks
2. To identify the learning algorithms and to know the issues of various feed forward and feedback neural networks.
3. To Understand the basic concepts of Associative Learning and pattern classification.
4. To solve real world problems using the concept of Artificial Neural Networks.

Course Outcomes:

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

CO1: Understand the basic features of neural systems and be able to build the neural model.

CO2: Perform the training of neural networks using various learning rules.

CO3: Grasping the use of Associative learning Neural Network

CO4: Describe the concept of Competitive Neural Networks

CO5: Implement the concept of Convolutional Neural Networks and its models

CO6: Use a new tool /tools to solve a wide variety of real-world problems

Course Contents**Unit I****Introduction to ANN****(07 Hours)**

Introduction to ANN, History of Neural Network, Structure and working of Biological Neural Network, Neural net architecture, Topology of neural network architecture, Features, Characteristics, Types, Activation functions, Models of neuron-Mc Culloch & Pitts model, Perceptron, Adaline model, Basic learning laws, Applications of neural networks, Comparison of BNN and ANN.

#Exemplar/Case Studies

Controlling Water Reservoirs, Rule Extractions

Mapping of Course Outcomes for Unit I

CO1

Unit II**Learning Algorithms****(07 Hours)**

Learning and Memory, Learning Algorithms, Numbers of hidden nodes, Error Correction and Gradient Descent Rules, Perceptron Learning Algorithms, Supervised Learning Backpropagation, Multilayered Network Architectures, Back propagation Learning Algorithm, Feed forward and feedback neural networks, example and applications.

#Exemplar/Case Studies

Medical diagnosis, Automated trading systems

Mapping of Course Outcomes for Unit II

CO2

Unit III**Associative Learning****(07 Hours)**

Introduction, Associative Learning, Hopfield network, Error Performance in Hopfield networks, simulated annealing, Boltzmann machine and Boltzmann learning, State transition diagram and false minima problem, stochastic update, simulated annealing.

Basic functional units of ANN for pattern recognition tasks: Pattern association, pattern classification and pattern mapping tasks.

#Exemplar/Case Studies

Understanding catastrophic, Interference in neural nets

Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Competitive learning Neural Network	07(Hours)
Components of CL network, Pattern clustering and feature mapping network, ART networks, Features of ART models, character recognition using ART network. Self-Organization Maps (SOM): Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Pattern Classification		
#Exemplar/Case Studies	A Translation System for Face-to-Face Dialog and Intelligent Help Systems	
Mapping of Course Outcomes for Unit IV		
Unit V	Convolution Neural Network	07(Hours)
Building blocks of CNNs, Architectures, convolution / pooling layers, Padding, Strided convolutions, Convolutions over volumes, SoftMax regression, Deep Learning frameworks, Training and testing on different distributions, Bias and Variance with mismatched data distributions, Transfer learning, multi-task learning, end-to-end deep learning, Introduction to CNN models: LeNet – 5, AlexNet, VGG – 16, Residual Networks		
#Exemplar/Case Studies	Large scale handwritten digit recognition problem	
Mapping of Course Outcomes for Unit V		
Unit VI	Applications of ANN	06(Hours)
Pattern classification – Recognition of Olympic games symbols, Recognition of printed Characters. Neocognitron – Recognition of handwritten characters. NET Talk: to convert English text to speech. Recognition of consonant vowel (CV) segments, texture classification and segmentation		
#Exemplar/Case Studies	Automating language translation	
Mapping of Course Outcomes for Unit VI		

Learning Resources

Text Books:

1. Neural Networks a Comprehensive Foundations, Simon Haykin, PHI edition.
2. Laurene Fausett:Fundamentals of Neural Networks: Architectures, Algorithms & Apps, Pearson, 2004.
3. An introduction to neural networks, Gurney, Kevin, CRC press.

Reference Books:

1. Artificial Neural Networks - B. Vegganarayana Prentice Hall of India P Ltd ,2005
2. Neural Networks in Computer Inteligance- Li Min Fu, MC GRAW HILL EDUCATION, 2003
3. Neural Networks -James A Freeman David M S Kapura, Pearson Education, 2004.
4. Introduction to Artificial Neural Systems- Jacek M. Zurada, JAICO Publishing House Ed.,2006.

e-Books:

- 1.<https://www.pdfdrive.com/neural-networks-a-comprehensive-foundationpdf-e18774300.html>
- 2.<https://www.pdfdrive.com/elements-of-artificial-neural-networks-e17103719.html>
- 3.<https://www.pdfdrive.com/neural-networks-methodology-and-applications-e38107895.html>

MOOC Courses:

- 1.<https://nptel.ac.in/courses/117105084>
2. <https://www.coursera.org/projects/predicting-weather-artificial-neural-networks>

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

Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
Elective II
317532(A): Robotics and Automation

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week##	03	Mid_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses, if any: Internet of Things (217529), Artificial Intelligence (310253)

Companion Course, if any: Mini Project (317536)

Course Objectives:

- To impart knowledge about basic mathematics related to industrial robots
- To Design and control application in robotics & automation Industries

Course Outcomes:

Course Outcomes –

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

CO1 – Demonstrate the Sensors, actuators, End effectors,

CO2 – Analyze Robot Kinematics and Dynamics with simulation

CO3 – Summarize control laws for simple robot

CO4 – Develop robot program for robot application

Course Contents

Unit I	Introduction to Automation and Robotics	(06 Hours)
Introduction to Automation, Types, Strategies, Automated Flow Lines, Automated Guided Vehicles, Automated Storage and Retrieval Systems, Introduction to CAD/ CAM/ CIM, Industry 4.0		
Introduction to Robotics – Laws of Robotics, Robot Anatomy, Classification of Robots, Robots Links and Joints, Degrees of Freedom, Robot Configurations, Work Envelope		
#Exemplar/Case Studies	Robot Specifications	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	Robot Sensors and Vision	(Hours)
Sensors – Contact and Proximity, Position, Force, velocity, Touch, Range, Tactile, Acoustic, Light Curtain, Sensor Selection		
Robot Vision – Components of vision system, image acquisition, Cameras, Image Storage and Image Processing, feature Extraction, Object recognition		
#Exemplar/Case Studies	Case study on sensor selection	
Mapping of Course Outcomes for Unit II	CO1	
Unit III	Robot Kinematics and Dynamics	(Hours)
3 Robot Kinematics – Translation and Rotation representation, Coordinate Transformation, Denavit Hartenberg parameters, Forward and Inverse Kinematics, Jacobian, Singularity and Statics		
Robot Dynamics – Forward and Inverse Dynamics, Equation of Motion using Euler – Lagrange Formulation and Newton – Euler Formulation		
#Exemplar/Case Studies	Case study on kinematic and dynamics of Industrial robot	

Mapping of Course Outcomes for Unit III	CO2	
Unit IV	Robot End Effectors and actuation systems	(Hours)
Robot End Effectors – Grippers - Mechanical, Pneumatic, Hydraulic, Magnetic, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers Actuators - Pneumatic Drives, Hydraulic Drives, Mechanical Drives, Electrical Drives - Servo Motors, Stepper Motors, BLDC motor, Micro actuators, selection of actuators, Power transmission systems for robot, Motion conversion.		
#Exemplar/Case Studies	Casestudy on Gripper design	
Mapping of Course Outcomes for Unit IV	CO1	
Unit V	Robot Control System	(Hours)
Embedded Systems – microcontroller architecture, Integration of Sensors and Actuators Basics of Control – Open and Closed Loop, Transfer Functions, Control Law Partitioning, PID Control, Linear and Nonlinear control, Force / Position Control, Adaptive control Introduction to Trajectory Planning, Artificial Intelligence in Robotics, Robotic Simulation		
#Exemplar/Case Studies	Casestudy on Robot controller	
Mapping of Course Outcomes for Unit V	CO3	
Unit VI	Robot Performance, Applications and programming	(Hours)
Robot Performance – Resolution, repeatability, accuracy, dexterity, Compliance, RCC Applications of Robots – in Unmanned systems, Defense, medical, Industries Robot Programming – Methods of Robot Programming, Lead through Programming, Motion Interpolation, Robot Language Structure, Programming in VAL II, motion commands, End effector and Sensor Commands, Monitor mode commands		
#Exemplar/Case Studies	Robot program on palletizing and Depalletizing	
Mapping of Course Outcomes for Unit VI	CO4	
Learning Resources		
Text Books:		
<ul style="list-style-type: none"> - Groover M.P.- Automation, production systems and computer integrated manufacturing’ - Prentice Hall of India - John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009 - R K Mittal & I J Nagrath, Robotics and Control, McGraw Hill Publication, 2015 - Ganesh Hegde, Industrial Robotics, Laxmi publication - S. K. Saha, Introduction to Robotics, TMH International - Groover, Industrial Robotics, Tata McGraw-Hill Education 		
Reference Books:		
<ul style="list-style-type: none"> - Mark W Spong, M. Vidyasagar, Robot Dynamics And Control, John Wiley & Sons - Richard D. Klafter, Robotics Engineering: An Integrated Approach, Pearson 		
e-Books:		
MOOC Courses:		

@The CO-PO mapping table

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

Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
Elective II
317532(B): Natural Language Processing

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week##	03	Mid_Semester(TH): 30 Marks End_Semester(TH): 70 Marks

Prerequisite Courses, if any: Discrete Mathematics (210241), Data Structures and Algorithms (210253), Artificial Intelligence (310254)

Companion Course, if any: Artificial Neural Network (317531), Mini Project (317536)

Course Objectives:

- To understand the basic concepts of Natural Language Processing (NLP)
- To understand use of morphological aspect in NLP
- To learn and implement syntax parsing techniques
- To learn and implement semantics parsing techniques
- To learn and implement Machine Translation techniques
- To design and develop different application using NLP

Course Outcomes:

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

CO1: Understand the fundamental concepts in field of NLP

CO2: Understand morphological aspect and processing in NLP

CO3: Distinguish among various techniques of syntax parsing

CO4: Understand use of various parsing techniques to parse sentence and extract meaning from its structure.

CO5: Apply different Machine translation techniques for translating a source to target language(s)

CO6: Design and implement different application using NLP

Course Contents

Unit I	Fundamentals of Natural Language Processing	(06 Hours)
History of NLP, Generic NLP system, levels of NLP, Knowledge in language processing, Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP, Approaches of NLP: Rule based, Data Based, Knowledge Based approaches		
#Exemplar/Case Studies	Comparative study of available libraries for Natural Language processing with respect to functionalities provided, platform dependence, supported NLP approaches, supported NLP tasks, advantages and disadvantages etc.	
Mapping of Course Outcomes for Unit I	CO1	
Unit II	Word level processing	(8 Hours)
Types of Morphology: English and Indian Languages, Finite-State Morphological Parsing, building a Finite-State Lexicon, Finite-State Transducers, FSTs for Morphological Parsing, Transducers and Orthographic rules, The Porter Stemmer, Word and Sentence Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance, Human Morphological Processing N-Grams: Building N-gram for spelling corrections, N-gram for language model.		
#Exemplar/Case Studies	Morphological Analyzer for Affix Stacking Languages: A Case Study of Marathi	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	Syntax Parsing	(8 Hours)

Constituency Grammars: Context free grammar, grammar rules for English, treebanks, grammar equivalence and normal forms, lexicalized grammar. **Constituency Parsing:** Ambiguity, CKY parsing, span based neural constituency parsing, evaluation parsers, partial parsing, CCG parsing, **Dependancy parsing:** dependancy relations, dependancy formalism, dependancy treebank, transition and graph based dependency parsing, evaluations.

#Exemplar/Case Studies	Dialogue systems and summarization	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Semantic Parsing	(8 Hours)
Word Senses and WordNet: Word senses, relation between senses, WordNet, wordsense disambiguation, WSD algorithm and task, Word sense inductions Semantic role labelling: semantic roles, diathesis alteration, problems with thematic roles, proposition bank, framenet, semantic role labelling, selection restrictions, decomposition of predicates, Lexicon for sentiment, affect and connotation: emotions, sentiment and affect lexicons, Creating Affect Lexicons by Human Labeling, Semi-supervised Induction of Affect Lexicons, Supervised Learning of Word Sentiment, Using Lexicons for Sentiment Recognition, Other tasks: Personality, Affect Recognition, Lexicon-based methods for Entity-Centric Affect, Connotation Frames.		
#Exemplar/Case Studies	Semantic Parsing Using Content and Context	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Machine Translation (MT)	(8 Hours)
Need of MT, Problems of Machine Translation, MT Approaches, Direct Machine Translations, Rule-Based Machine Translation, Knowledge Based MT System, Statistical Machine Translation (SMT), Parameter learning in SMT (IBM models) using EM, Encoder-decoder architecture, Neural Machine Translation		
#Exemplar/Case Studies	ANN, RNN	
Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Applications of NLP	(6 Hours)
Information retrieval-Vector Space Model, Information Extraction using sequence labelling, Question answers system, categorization, summarization, sentiment analysis, Named Entity Recognition. Analyzing text with NLTK, Chatbot using Dialogflow		
#Exemplar/Case Studies	Amazon Lex ,NLTK	
Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		

Text Books:

1. Daniel Jurafsky, James H. Martin, “Speech and Language Processing”, Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and Hinrich Schutze,, “Foundations of Statistical Natural Language Processing” , MIT Press, 1999

Reference Books:

1. Steven Bird,Ewan Klein and Edward Loper,” NLP with Python:Analyzing text with the

Natural Language Toolkit”, O'Reilly Media, Inc

2. Nitin Indurkha and Fred J. Damerau, “Handbook of Natural Language Processing”, 2nd ed. CRC press.

e-Books:

1. Yoav Goldberg. A primer on neural network models for natural language processing, 2015.
URL <http://u.cs.biu.ac.il/~yogo/nlp.pdf>

MOOC Courses:

@The CO-PO mapping table

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

Savitribai Phule Pune University**Third Year of Artificial Intelligence and Data Science (2019 Course)**[Home](#)**Elective II****310254(C): Cloud Computing****Teaching Scheme:****Lecture: 04 Hours/Week^{##}****Credit: 03****Examination Scheme:****Mid-Semester (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:** Computer Networks (317521)**Companion Course:** Mini Project (317536)**Course Objectives:**

- To study fundamental concepts of cloud computing
- To learn various data storage methods on cloud
- To understand the implementation of Virtualization in Cloud Computing
- To learn the application and security on cloud computing
- To study risk management in cloud computing
- To understand the advanced technologies in cloud computing

Course Outcomes:*On completion of the course, learners should be able to***CO1:** Understand the different Cloud Computing environment**CO2:** Use appropriate data storage technique on Cloud, based on Cloud application**CO3:** Analyze virtualization technology and install virtualization software**CO4:** Develop and deploy applications on Cloud**CO5:** Apply security in cloud applications**CO6:** Use advance techniques in Cloud Computing**Course Contents**

Unit I	Introduction to Cloud Computing	07 Hours
---------------	--	-----------------

Importance of Cloud Computing, Characteristics, Pros and Cons of Cloud Computing, Migrating into the Cloud, Seven-step model of migration into a Cloud, Trends in Computing. **Cloud Service Models:** SaaS, PaaS, IaaS, Storage. **Cloud Architecture:** Cloud Computing Logical Architecture, Developing Holistic Cloud Computing Reference Model, Cloud System Architecture, Cloud Deployment Models.

#Exemplar/Case Studies	Cloud Computing Model of IBM	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Data Storage and Cloud Computing	07 Hours

Data Storage: Introduction to Enterprise Data Storage, Direct Attached Storage, Storage Area Network, Network Attached Storage, Data Storage Management, File System, Cloud Data Stores, Using Grids for Data Storage. **Cloud Storage:** Data Management, Provisioning Cloud storage, Data Intensive Technologies for Cloud Computing. **Cloud Storage from LANs to WANs:** Cloud Characteristics, Distributed Data Storage.

#Exemplar/Case Studies	Online Book Marketing Service, Online Photo Editing Service
*Mapping of Course Outcomes for Unit II	CO2

Unit III	Virtualization in Cloud Computing	07 Hours
Introduction: Definition of Virtualization, Adopting Virtualization, Types of Virtualization, Virtualization Architecture and Software, Virtual Clustering, Virtualization Application, Pitfalls of Virtualization. Grid, Cloud and Virtualization: Virtualization in Grid, Virtualization in Cloud, Virtualization and Cloud Security. Virtualization and Cloud Computing: Anatomy of Cloud Infrastructure, Virtual infrastructures, CPU Virtualization, Network and Storage Virtualization.		
#Exemplar/Case Studies	Xen: Para virtualization, VMware: Full Virtualization, Microsoft Hyper-V	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Cloud Platforms and Cloud Applications	07 Hours
Amazon Web Services (AWS): Amazon Web Services and Components, Amazon Simple DB, Elastic Cloud Computing (EC2), Amazon Storage System, Amazon Database services (Dynamo DB). Microsoft Cloud Services: Azure core concepts, SQL Azure, Windows Azure Platform Appliance. Cloud Computing Applications: Healthcare: ECG Analysis in the Cloud, Biology: Protein Structure Prediction, Geosciences: Satellite Image Processing, Business and Consumer Applications: CRM and ERP, Social Networking, Google Cloud Application: Google App Engine. Overview of OpenStack architecture.		
#Exemplar/Case Studies	Multiplayer Online Gaming	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Security in Cloud Computing	07 Hours
Risks in Cloud Computing: Risk Management, Enterprise-Wide Risk Management, Types of Risks in Cloud Computing. Data Security in Cloud: Security Issues, Challenges, advantages, Disadvantages, Cloud Digital persona and Data security, Content Level Security. Cloud Security Services: Confidentiality, Integrity and Availability, Security Authorization Challenges in the Cloud, Secure Cloud Software Requirements, Secure Cloud Software Testing.		
#Exemplar/Case Studies	Cloud Security Tool: Acunetix.	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Advanced Techniques in Cloud Computing	07 Hours
Future Trends in cloud Computing, Mobile Cloud, Automatic Cloud Computing: Comet Cloud. Multimedia Cloud: IPTV, Energy Aware Cloud Computing, Jungle Computing, Distributed Cloud Computing Vs Edge Computing, Containers, Docker, and Kubernetes, Introduction to DevOps. IOT and Cloud Convergence: The Cloud and IoT in your Home, The IOT and cloud in your Automobile, PERSONAL: IoT in Healthcare.		
#Exemplar/Case Studies	Case studies on Dev Ops: DocuSign, Forter, Gengo.	
*Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		

Text Books :

1. A. Srinivasan, J. Suresh, "Cloud Computing: A Practical Approach for Learning and Implementation", Pearson, ISBN: 978-81-317-7651-3
2. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, "Mastering Cloud Computing", McGraw Hill Education, ISBN-13:978-1-25-902995-0

Reference Books :

1. James Bond ,“The Enterprise Cloud”, O'Reilly Media, Inc. ISBN: 9781491907627
2. Dr. Kris Jamsa, “Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more”, Wiley Publications, ISBN: 978-0-470-97389-9
3. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, “Cloud Computing: A Practical Approach”, 2010, The McGraw-Hill.
4. Gautam Shrof, “ENTERPRISE CLOUD COMPUTING Technology Architecture, Applications”, Cambridge University Press, ISBN: 9780511778476
5. Tim Mather, Subra K, Shahid L.,”Cloud Security and Privacy”, Orelly, ISBN-13 978-81-8404-815-5
6. Dr. Kumar Saurabh, “Cloud Computing, 4ed: Architecting Next-Gen Transformation Paradigms”, Wiley publication, ISBN: 9788126570966
7. Rishabh Sharma, “Cloud Computing: Fundamentals, Industry Approach and Trends”, Wiley publication, ISBN:

e-Books :

- <https://sjceodisha.in/wp-content/uploads/2019/09/CLOUD-COMPUTING-Principles-and-Paradigms.pdf>
- <https://studytm.files.wordpress.com/2014/03/hand-book-of-cloud-computing.pdf>
- <https://arpitapatel.files.wordpress.com/2014/10/cloud-computing-bible1.pdf>
- <https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.500-291r2.pdf>

MOOCs Courses link:

- Cloud Computinghttps://onlinecourses.nptel.ac.in/noc21_cs14/preview?
- Cloud Computing and Distributed System:
https://onlinecourses.nptel.ac.in/noc21_cs15/preview?
- <https://www.digimat.in/nptel/courses/video/106105167/L01.html>
- <https://www.digimat.in/nptel/courses/video/106105167/L03.html>
- <https://www.digimat.in/nptel/courses/video/106105167/L20.html>

@ The CO-PO Mapping Matrix

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

Savitribai Phule Pune University**Third Year of Artificial Intelligence and Data Science (2019 Course)**[Home](#)**Elective II****310254(D): Software Modeling and Architecture****Teaching Scheme:****Credit: 03****Examination Scheme:****Lecture: 04 Hours/Week##****Mid-Semester (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:** Object Oriented Programming (210243), Software Engineering (210253)**Companion Course: Mini Project (317536)****Course Objectives:**

- To understand and apply Object Oriented concept for designing Object Oriented based model or application
- To transform Requirement document to appropriate design
- To acquaint with the interaction between quality attributes and software architecture
- To understand different architectural designs, transform them into proper model and document them
- To understand software architecture with case studies and explore with examples, use of design pattern application

Course Outcomes:*On completion of the course, learners should be able to***CO1:** Analyze the problem statement (SRS) and choose proper design technique for designing web-based/ desktop application**CO2:** Design and analyze an application using UML modeling as fundamental tool**CO3:** Evaluate software architectures**CO4:** Use appropriate architectural styles and software design patterns**CO5:** Apply appropriate modern tool for designing and modeling**Course Contents****Unit I****Concepts of Software Modeling****07 Hours**

Software Modeling: Introduction to Software Modeling, Advantages of modeling, Principles of modeling. **Evolution of Software Modeling and Design Methods:** Object oriented analysis and design methods, Concurrent, Distributed Design Methods and Real-Time Design Methods, Model Driven Architecture (MDA), 4+1 Architecture, Introduction to UML, UML building Blocks, COMET Use Case-Based Software Life Cycle. **Requirement Study:** Requirement Analysis, SRS design, Requirements Modeling. **Use Case:** Actor and Use case identification, Use case relationship (Include, Extend, Use case Generalization, Actor Generalization), Use case template.

#Exemplar/Case Studies	Requirement modeling and use case modeling for Real life applications (e.g., Online shopping system)
-------------------------------	--

*Mapping of Course Outcomes for Unit I	CO1, CO2
---	----------

Unit II**Static Modeling****07 Hours**

Study of classes (analysis level and design level classes). **Methods for identification of classes:** RUP (Rational Unified Process), CRC (Class, Responsibilities and Collaboration), Use of Noun Verb analysis (for identifying entity classes, controller classes and boundary classes). **Class Diagram:** Relationship between classes, Generalization/Specialization Hierarchy, Composition and Aggregation Hierarchies, Associations Classes, Constraints.

Object diagram, Package diagram, Component diagram, Composite Structure diagram, Deployment Diagram.

#Exemplar/Case Studies	UML Static Diagrams for Real life applications (e.g., Online shopping system).	
*Mapping of Course Outcomes for Unit II	CO1 ,CO2	
Unit III	Dynamic Modeling	07 Hours
<p>Activity diagram: Different Types of nodes, Control flow, Activity Partition, Exception handler, Interruptible activity region, Input and output parameters, Pins.</p> <p>Interaction diagram: Sequence diagram, Interaction Overview diagram, State machine diagram, Advanced State Machine diagram, Communication diagram, Timing diagram.</p>		
#Exemplar/Case Studies	UML dynamic Diagrams of for Real life applications.	
*Mapping of Course Outcomes for Unit III	CO1 ,CO2	
Unit IV	Software Architecture and Quality Attributes	07 Hours
<p>Introduction to Software Architecture, Importance of Software Architecture, Architectural Structure and Views. Architectural Pattern: common module, Common component-and-connector, Common allocation.</p> <p>Quality Attributes: Architecture and Requirements, Quality Attributes and Considerations</p>		
#Exemplar/Case Studies	Case study of any real-life application	
*Mapping of Course Outcomes for Unit IV	CO3	
Unit V	Architectural Design and Documentation	07 Hours
<p>Architecture in the Life Cycle: Architecture in Agile Projects, Architecture and Requirements, Designing an Architecture. Documenting Software Architecture: Notations, Choosing and Combining views, Building the documentation Package, Documenting Behavior, Documenting Architecture in an Agile Development Project.</p>		
#Exemplar/Case Studies	Air Traffic Control.	
*Mapping of Course Outcomes for Unit V	CO4 , CO5	
Unit VI	Design Patterns	07 Hours
<p>Design Patterns: Introduction, Different approaches to select Design Patterns. Creational patterns: Singleton, Factory, Structural pattern: Adapter, Proxy. Behavioral Patterns: Iterator, Observer Pattern with applications.</p>		
#Exemplar/Case Studies	Flight Simulation	
*Mapping of Course Outcomes for Unit VI	CO4, CO5	
Learning Resources		
<p>Text Books :</p> <ol style="list-style-type: none"> 1. Jim Arlow, Ila Neustadt, "UML 2 and the unified process –practical object-oriented analysis and design", Addison Wesley, Second edition, ISBN 978-0201770605. 2. Len Bass, Paul Clements, Rick Kazman, "Software Architecture in Practice", Second Edition, Pearson ,ISBN 978-81-775-8996-2 		

3. Erich Gamma, "Design Patterns", Pearson, ISBN 0-201-63361-2.

Reference Books :

1. Hassan Gomaa, "Software Modeling and Design- UML, Use cases, Patterns and Software Architectures", Cambridge University Press, 2011, ISBN 978-0-521-76414-8
2. Gardy Booch, James Rumbaugh, Ivar Jacobson, "The unified modeling language user guide" , Pearson Education, Second edition, 2008, ISBN 0-321-24562
3. Ian Sommerville, "Software Engineering", Addison and Wesley, ISBN 0-13-703515-2

e-Books :

- <https://ebookpdf.com/roger-s-pressman-software-engineering>
- <https://dhomaseghanshyam.files.wordpress.com/2016/02/gomaa-softwaremodellinganddesign.pdf>
- <https://balu051989.files.wordpress.com/2011/06/the-unified-modeling-language-user-guide-by-grady-booch-james-rumbaugh-ivar-jacobson.pdf>
- [http://index-of.co.uk/Engineering/Software%20Engineering%20\(9th%20Edition\).pdf](http://index-of.co.uk/Engineering/Software%20Engineering%20(9th%20Edition).pdf)

MOOCs Courses link

- <https://nptel.ac.in/courses/106/105/106105224/>
- https://onlinecourses.nptel.ac.in/noc20_cs59/preview
- https://onlinecourses.nptel.ac.in/noc20_cs84/preview

@ The CO-PO Mapping Matrix

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

Savitribai Phule Pune University**Third Year of Artificial Intelligence and Data Science (2019 Course)****317533: Software Laboratory II**

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

Prerequisite Courses, if any: Software Laboratory I (317526),Elective I Laboratory (317525)**Companion Course, if any:Artificial Neural Network (317534)****Course Objectives:**

- To understand basic techniques and strategies of learning algorithms
- To understand various artificial neural network models
- To make use of tools to solve the practical problems in real field using Pattern Recognition, Classification and Optimization

Course Outcomes:

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

- CO1: Model artificial Neural Network, and to analyze ANN learning, and its applications
 CO2: Perform Pattern Recognition, Linear classification.
 CO3: Develop different single layer/multiple layer Perception learning algorithms
 CO4: Design and develop applications using neural networks.

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and handwritten write-upof each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm,flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable),conclusion/analysis. **Program codes with sample output of all performed assignments are to be submitted as softcopy.**

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

Guidelines for Laboratory / Term Work Assessment

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

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of Hungarian notation, proper indentation and comments. Use of open source software is to be encouraged. In addition to these, instructor may assign one real life application in the form of a mini-project based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

Set of suggested assignment list is provided in groups- A, B, and C. Each student must perform at least

10 assignments and one mini project (at least 6 from group A, 2 from group B and 2 from group C)

Group A and B assignments should be implemented in Python without using built-in methods for major functionality of assignment. Operating System recommended:- 64-bit Open source Linux or its derivative Programming tools recommended: - Open Source Python, Programming tool like Jupyter Notebook, Pycharm, Spyder, Tensorflow.

Guidelines for Practical Examination

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

Virtual Laboratory:

<https://cse22-iiith.vlabs.ac.in/>

http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

Suggested List of Laboratory Experiments/Assignments

Group A (Any 6)

1. Write a Python program to plot a few activation functions that are being used in neural networks.
2. Generate ANDNOT function using McCulloch-Pitts neural net by a python program.
3. Write a Python Program using Perceptron Neural Network to recognise even and odd numbers.
Given numbers are in ASCII form 0 to 9
4. With a suitable example demonstrate the perceptron learning law with its decision regions using python. Give the output in graphical form.
5. Write a python Program for Bidirectional Associative Memory with two pairs of vectors.
6. Write a python program to recognize the number 0, 1, 2, 39. A 5 * 3 matrix forms the numbers. For any valid point it is taken as 1 and invalid point it is taken as 0. The net has to be trained to recognize all the numbers and when the test data is given, the network has to recognize the particular numbers
7. Implement Artificial Neural Network training process in Python by using Forward Propagation, Back Propagation.
8. Create a Neural network architecture from scratch in Python and use it to do multi-class classification on any data.

Parameters to be considered while creating the neural network from scratch are specified as:

- (1) No of hidden layers : 1 or more
- (2) No. of neurons in hidden layer: 100
- (3) Non-linearity in the layer : Relu
- (4) Use more than 1 neuron in the output layer. Use a suitable threshold value

Use appropriate Optimisation algorithm

Group B (Any 4)

1. Write a python program to show Back Propagation Network for XOR function with Binary Input and Output
2. Write a python program to illustrate ART neural network.
3. Write a python program in python program for creating a Back Propagation Feed-forward neural network
4. Write a python program to design a Hopfield Network which stores 4 vectors
5. Write Python program to implement CNN object detection. Discuss numerous performance evaluation metrics for evaluating the object detecting algorithms' performance.

Group C (Any 3)

1. How to Train a Neural Network with TensorFlow/Pytorch and evaluation of logistic regression using tensorflow

2. TensorFlow/Pytorch implementation of CNN

3. For an image classification challenge, create and train a ConvNet in Python using TensorFlow. Also try to improve the performance of the model by applying various hyper parameter tuning to reduce the overfitting or under fitting problem that might occur. Maintain graphs of comparisons.

4. MNIST Handwritten Character Detection using PyTorch, Keras and Tensorflow

Mini Project

Car Object Detection using (ConvNet/CNN) Neural Network

Car Object Data: Data Source – <https://www.kaggle.com/datasets/sshikamaru/car-object-detection>

The dataset contains images of cars in all views.

Training Images – Set of 1000 files

Use Tensorflow, Keras & Residual Network resNet50

Constructs comparative outputs for various Optimisation algorithms and finds out good accuracy.

OR

Mini Project to implement CNN object detection on any data. Discuss numerous performance evaluation metrics for evaluating the object detecting algorithms' performance, Take outputs as a comparative results of algorithms.

Learning Resources

Text Books:

1. Neural Networks a Comprehensive Foundations, Simon Haykin, PHI edition.
2. Laurene Fausett:Fundamentals of Neural Networks: Architectures, Algorithms & Apps, Pearson, 2004.
3. Learn TensorFlow 2.0: Implement Machine Learning and Deep Learning Models with Python 1st ed. Edition, Apress publication

Reference Books:

1. Getting Started with TensorFlow, by Giancarlo Zaccone
2. AI and Machine learning for coders by Laurence Moroney, O'Reilly Media, Inc.

e-Books:

1. https://www.inf.ed.ac.uk/teaching/courses/nlu/assets/reading/Gurney_et_al.pdf
2. <http://neuralnetworksanddeeplearning.com/>

MOOC Courses:

1. <http://neuralnetworksanddeeplearning.com/>
2. <https://www.coursera.org/learn/convolutional-neural-networks-tensorflow>
3. <https://nptel.ac.in/courses/106106213>

@The CO-PO mapping table

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

Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317534: Software Laboratory III

Teaching Scheme:	Credit	Examination Scheme:
PR: 04 Hours/Week	02	Term Work (TW): 50 Marks Practical(PR): 25 Marks

Prerequisite Courses, if any: Data Base Management System (310241)

Companion Course, if any: Data Science (317529)

Course Objectives:

- To understand principles of Data Science for the analysis of real time problems
- To develop in depth understanding and implementation of the key technologies in Data Science and Data Analytics
- To analyze and demonstrate knowledge of statistical data analysis techniques for decision-making
- To gain practical, hands-on experience with statistics programming languages and Data tools

Course Outcomes:

On completion of the course, learners will be able to

CO1: Apply principles of Data Science for the analysis of real time problems

CO2: Implement data representation using statistical methods

CO3: Implement and evaluate data analytics algorithms

CO4: Perform text preprocessing

CO5: Implement data visualization techniques

CO6: Use cutting edge tools and technologies to analyze Data

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 students in the form of a 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 journals must be avoided. Use of DVD containing student 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, punctuality and sincerity.

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 needs 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. Instructors may also set one assignment or mini-project that is suitable to respective branch beyond the scope of the syllabus.

Set of suggested assignment list is provided in groups- A and B. Each student must perform 13 assignments (10 from group A, 3 from group B), 2 mini project from Group C

Operating System recommended :- 64-bit Open source Linux or its derivative Programming tools recommended: - JAVA/Python/R/Scala

Virtual Laboratory:

- ["Welcome to Virtual Labs - A MHRD Govt of India Initiative"](#)
- <http://cse20-iiith.vlabs.ac.in>List%20of%20Experiments.html?domain=Computer%20Science>

List of Assignments

Group A : Data Science

1) Data Wrangling, I

Perform the following operations using Python on any open source dataset (e.g., data.csv)

1. Import all the required Python Libraries.
2. Locate open source data from the web (e.g., <https://www.kaggle.com>). Provide a clear description of the data and its source (i.e., URL of the web site).
3. Load the Dataset into pandas dataframe.
4. Data Preprocessing: check for missing values in the data using pandas isnull(), describe() function to get some initial statistics. Provide variable descriptions. Types of variables etc. Check the dimensions of the data frame.
5. Data Formatting and Data Normalization: Summarize the types of variables by checking the data types (i.e., character, numeric, integer, factor, and logical) of the variables in the data set. If variables are not in the correct data type, apply proper type conversions.
6. Turn categorical variables into quantitative variables in Python.

In addition to the codes and outputs, explain every operation that you do in the above steps and explain everything that you do to import/read/scrape the data set.

2) Data Wrangling II

Create an “Academic performance” dataset of students and perform the following operations using Python.

1. Scan all variables for missing values and inconsistencies. If there are missing values and/or inconsistencies, use any of the suitable techniques to deal with them.
2. Scan all numeric variables for outliers. If there are outliers, use any of the suitable techniques to deal with them.
3. Apply data transformations on at least one of the variables. The purpose of this transformation should be one of the following reasons: to change the scale for better understanding of the variable, to convert a non-linear relation into a linear one, or to decrease the skewness and convert the distribution into a normal distribution.

Reason and document your approach properly.

3) Descriptive Statistics - Measures of Central Tendency and variability

Perform the following operations on any open source dataset (e.g., data.csv)

1. Provide summary statistics (mean, median, minimum, maximum, standard deviation) for a

dataset (age, income etc.) with numeric variables grouped by one of the qualitative (categorical) variable. For example, if your categorical variable is age groups and quantitative variable is income, then provide summary statistics of income grouped by the age groups. Create a list that contains a numeric value for each response to the categorical variable.

2. Write a Python program to display some basic statistical details like percentile, mean, standard deviation etc. of the species of 'Iris-setosa', 'Iris-versicolor' and 'Iris-versicolor' of iris.csv dataset.

Provide the codes with outputs and explain everything that you do in this step.

4) Data Analytics I

Create a Linear Regression Model using Python/R to predict home prices using Boston Housing Dataset (<https://www.kaggle.com/c/boston-housing>). The Boston Housing dataset contains information about various houses in Boston through different parameters. There are 506 samples and 14 feature variables in this dataset.

The objective is to predict the value of prices of the house using the given features.

5) Data Analytics II

1. Implement logistic regression using Python/R to perform classification on Social_Network_Ads.csv dataset.
2. Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given dataset.

6) Data Analytics III

1. Implement Simple Naïve Bayes classification algorithm using Python/R on iris.csv dataset.
2. Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given dataset.

7) Text Analytics

1. Extract Sample document and apply following document preprocessing methods: Tokenization, POS Tagging, stop words removal, Stemming and Lemmatization.
2. Create representation of documents by calculating Term Frequency and Inverse DocumentFrequency.

8) Data Visualization I

1. Use the inbuilt dataset 'titanic'. The dataset contains 891 rows and contains information about the passengers who boarded the unfortunate Titanic ship. Use the Seaborn library to see if we can find any patterns in the data.
2. Write a code to check how the price of the ticket (column name: 'fare') for each passenger is distributed by plotting a histogram.

9) Data Visualization II

1. Use the inbuilt dataset 'titanic' as used in the above problem. Plot a box plot for distribution of age with respect to each gender along with the information about whether they survived or not. (Column names : 'sex' and 'age')
2. Write observations on the inference from the above statistics.

10) Data Visualization III

Download the Iris flower dataset or any other dataset into a DataFrame. (e.g., <https://archive.ics.uci.edu/ml/datasets/Iris>). Scan the dataset and give the inference as:

1. List down the features and their types (e.g., numeric, nominal) available in the dataset.
2. Create a histogram for each feature in the dataset to illustrate the feature distributions.
3. Create a boxplot for each feature in the dataset.
4. Compare distributions and identify outliers.

Group B- Data Analytics – JAVA/SCALA(Any Two)

- 1.Create databases and tables, insert small amounts of data, and run simple queries using Impala
- 2.Design a distributed application using MapReduce which processes a log file of a system.
- 3.Write a simple program in SCALA using Apache Spark framework

Group C Group C- Mini Projects/ Case Study – PYTHON/R (Any ONE Mini Project)

1. Write a case study on Global Innovation Network and Analysis (GINA). Components of analytic plan are
 - Discovery business problem framed,
 - Data,
 - Model planning analytic technique and
 - Results and Key findings.
2. Use the following dataset and classify tweets into positive and negative tweets.
<https://www.kaggle.com/ruchi798/data-science-tweets>
3. Develop a movie recommendation model using the scikit-learn library in python. Refer dataset
https://github.com/rashida048/Some-NLP-Projects/blob/master/movie_dataset.csv
4. Use the following covid_vaccine_statewise.csv dataset and perform following analytics on the given dataset https://www.kaggle.com/sudalairajkumar/covid19-in-india?select=covid_vaccine_statewise.csv a. Describe the dataset b. Number of persons state wise vaccinated for first dose in India c. Number of persons state wise vaccinated for second dose in India d. Number of Males vaccinated e. Number of females vaccinated
5. Write a case study to process data driven for Digital Marketing OR Health care systems with Hadoop Ecosystem components as shown. (Mandatory)
 - HDFS: Hadoop Distributed File System
 - YARN: Yet Another Resource Negotiator
 - MapReduce: Programming based Data Processing
 - Spark: In-Memory data processing
 - PIG, HIVE: Query based processing of data services
 - HBase: NoSQL Database (Provides real-time reads and writes)
 - Mahout, Spark MLlib: (Provides analytical tools) Machine Learning algorithm libraries
 - Solar, Lucene: Searching and Indexing

Learning Resources

Reference Books:

1. Chirag Shah, “A Hands-On Introduction To Data Science”, Cambridge University Press,(2020), ISBN : ISBN 978-1-108-47244-9.
2. Python for Data Analysis by Wes McKinney published by O' Reilly media, ISBN : 978-1-449-31979-3.
3. Scikit-learn Cookbook , Trent hauk,Packt Publishing, ISBN: 9781787286382
4. R Kent Dybvig, —the Scheme Programming Language, MIT Press, ISBN 978-0-262-51298-5.
5. Data Analytics with Hadoop, Jenny Kim, Benjamin Bengfort, OReilly Media, Inc.
6. Python Data Science Handbook by Jake VanderPlas
<https://tanhiamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf>
7. An Introduction to Statistical Learning by Gareth James
<https://www.ime.unicamp.br/~dias/Intoduction%20to%20Statistical%20Learning.pdf>
8. Cay S Horstmann, —Scala for the Impatient!, Pearson, ISBN: 978-81-317-9605-4,
9. Scala Cookbook, Alvin Alexander, O'Reilly, SPD,ISBN: 978-93-5110-263-2

References :

- <https://www.simplilearn.com/data-science-vs-big-data-vs-data-analytics-article>
- <https://hadoop.apache.org/docs/current/hadoop-mapreduce-client/hadoop-mapreduce-client-core/MapReduceTutorial.html>
- <https://www.edureka.co/blog/hadoop-ecosystem>
- https://www.edureka.co/blog/mapreduce-tutorial/#mapreduce_word_count_example

- <https://github.com/vasanth-mahendran/weather-data-hadoop>
- <https://spark.apache.org/docs/latest/quick-start.html#more-on-dataset-operations>
- <https://www.scala-lang.org/>

MOOC Courses:

- https://onlinecourses.nptel.ac.in/noc21_cs33/preview
- <https://nptel.ac.in/courses/106/104/106104189/>
- https://onlinecourses.nptel.ac.in/noc20_cs92/preview
- <https://nptel.ac.in/courses/106/106/106106212/>

@The CO-PO mapping table

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

Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317535: Internship

Teaching Scheme:	Credit	Examination Scheme:
**	04	Term Work (TW): 50 Marks Oral(OR): 50 Marks

Course Objectives:

- To provide the work experience that can help students to put their education into practice.
- To encourage and provide opportunities for students to get professional experience through internships.
- To learn and apply knowledge gained through academics to real life/industrial situations.
- To get familiar with various technologies and tools used in industries for development of their applications.
- To inculcate professional and societal ethics.
- To create awareness of social, economic and administrative considerations in the working environment of industry organizations.

Course Outcomes:

On completion of the course, learners should be able to

CO1: To demonstrate professional competence through industry internship.

CO2: To apply knowledge gained through academics to a professional environment during internship.

CO3: To select appropriate technology and tools to solve a given real time problem.

CO4: To demonstrate abilities of a responsible professional and use ethical practices in day today life.

CO5: To create professional and social network and develop relationships with industry people and get exposure to future employers.

CO6: To explore various career opportunities in different domains and decide career goals.

Guidelines :

Internships are skill development, making students aware about the industrial environment, professional ethics, and career development opportunities. Students with well-identified internship goals make better utilization of practical experience in a field/broad area chosen.

The well-skilled and properly groomed interns are always in demand for industries/organizations. Industrial internships are like learning in the supervised mode and shaping one's career with pre identified goals. It's an important aspect as employers are looking for employees who are skilled and aware of the industry environment, practices, procedures, and culture. The intern will focus on a particular task or part of the project concisely as it is structured, short-term, and supervised.

The engineering undergraduate can be exposed to the procedures and practices followed in the industry through the traditional teaching-learning process but it is always restricted by the simulation horizons so it is being placed on the actual background to gear up the skills. An opportunity, of engineering internships, will help interns to gear up and affirm conceptual learning in academics.

Duration

Internship is to be completed after semester 5 and before commencement of semester 6 of at least 4 to 6 weeks; and it is to be assessed and evaluated in semester 6.

Internship Work Identification

The student may choose to undergo an Internship in Industry/Government

Organizations/NGO/MSME/Rural Internship/ Innovation/IPR/Entrepreneurship. The student may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internships with industry/NGO's/Government organizations/Micro/Small/ Medium enterprises to make themselves ready for the industry[1].

Students must register at Internshala[2]. Students must get Internship proposals sanctioned by the college authorities well in advance. The internship work identification process should be initiated in the semester-5 in coordination with the training and placement cell/ industry-institute cell/ internship cell. This will help students to start their internship work on time. Internship is to be completed after semester-5 and before commencement of semester-6 of at least 4 to 6 weeks and it is to be assessed and evaluated in semester-6.

Students can take internship work in the form of the following but not limited to:

- Working for a consultancy/ research project
- Contribution in Incubation/ Innovation/ Entrepreneurship Cell/ Institutional Innovation
- Council/ startups cells of institute
- Learning at the Departmental Lab/Tinkering Lab/ Institutional workshop,
- Development of new product/ Business Plan/ registration of start-up
- Industry / Government Organization Internship
- Internship through Internshala
- In-house product development, intercollegiate, inter-department research internship under research lab/group, micro/small/medium enterprise/online internship
- Research internship under professors, IISC, IIT's, Research organizations
- NGOs or Social Internships, rural internships
- Participate in open source development.

Internship Diary/Internship Workbook

Students must maintain an Internship Diary/ Internship Workbook. The main purpose of maintaining a diary/workbook is to cultivate the habit of documenting. The students should record in the daily training diary the day-to-day account of the observations, impressions, information gathered, and suggestions given if any. The training diary/workbook should be signed every day by the supervisor.

Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry supervisor to the Institute immediately after the completion of the training.

Internship Work Evaluation

Every student needs to prepare and maintain the documents with valid evidence of the activities done by him/her in the form of an internship diary or an internship workbook. The evaluation of these activities will be carried out by the Programme Head/Internship In-charge/Project Head/ Faculty mentor or Industry supervisor based on a satisfactory compilation of internship activities /sub-activities, effective practical work, domain knowledge, well understanding of concepts, the level of achievement expected, the evidence needed to assign the points and the duration for certain activities. Assessment and evaluation are to be done in consultation with the internship supervisor (Internal and External supervisors from the place of internship)

Recommended evaluation parameters:

Post Internship, Internal Evaluation Term work (Internship Diary/Workbook and Internship Report) - 50 Marks and Oral/Seminar Presentation – 50 Marks

Evaluation through seminar presentation at the Institute

The student will give a seminar based on his internship report/workbook before the panel of experts

constituted by the concerned department as per the norms of the institute.

The evaluation will be based on the following criteria:

- Domain knowledge and skill
- Presentation/communication skill
- Teamwork
- Innovation/Creativity
- Planning & Organizational skills
- Adaptability
- Analytical Skills
- Attitude & Behavior at work
- Societal Understanding
- Ethics
- Regularity and punctuality
- Attendance record
- Diary/Workbook
- Student's Feedback from External Internship Supervisor

After completion of the Internship, the student should prepare a comprehensive report that includes what he/she has observed, monitored and learnt during the training period.

The internship Diary/workbook may be evaluated on the basis of following parameters:

- Proper and timely documented entries
- Time to time maintaining the internship diary
- Adequacy & quality of information recorded
- Relevant information gathered and analyzed
- Thought process and recording tools and techniques used
- Structuring the information

Internship Report

The report shall be prepared and presented covering the following recommended fields but limited to,

- Title/Cover Page
- Internship completion certificate
- Internship Place Details- Company background-organization and activities/Scope and object of the study / Supervisor details
- Index/Table of Contents
- Introduction
- Title/Problem statement/objectives
- Motivation/Scope and rationale of the study
- Methodological details (tools and techniques used)
- Results / Analysis /Inferences
- Conclusion and future scope
- Suggestions / Recommendations for improvement to industry (if any)
- Attendance Record
- Acknowledgement
- List of references (Library books, magazines, web references and other sources)

Feedback from internship supervisor(External and Internal)

After completion of internship, the faculty coordinator should collect feedback about the student with the following recommended parameters :

Technical knowledge gained through internship, Discipline, Sincerity and Punctuality, Commitment, Willingness to do the work, Individual work, Team work, Leadership, Verbal and written communication skills.

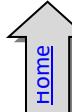
Reference:

[1] <https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf>

[2] <https://internship.aicte-india.org/>

@The CO-PO Mapping table

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



Savitribai Phule Pune University

Third Year of Artificial Intelligence and Data Science (2019 Course)

317536: Mini Project

Teaching Scheme:	Credit	Examination Scheme:
TH: 02 Hours/Week	01	Term Work (TW): 50 Marks Oral(OR): 25 Marks

Prerequisite Courses, if any: Computer Networks (317521)

Companion Course, if any: Cyber Security (317530), Elective II**

Part A Cyber Security

Course Objectives:

- To understand threats/vulnerabilities to networks and countermeasures.
- To provide understanding of cryptography and its applications.
- To explain various approaches to Encryption techniques.
- To understand working of firewall and IDs.

Course Outcomes:

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

- CO1:** Identify basic security attacks and services
CO2: Analyze the vulnerabilities and design a security solution.
CO3: Implement symmetric and asymmetric key algorithms
CO4: Demonstrate network security applications, Firewall, IDs.

List of Assignments (any five assignments)

1. Implementation of S-DES
2. Implementation of S-AES
3. Implementation of Diffie-Hellman key exchange
4. Implementation of RSA.
5. Implementation of ECC algorithm.
6. Enable/Configure (windows/ubuntu)firewall. Create rules to filter network traffic and to block unauthorized network traffic.
7. Configure and demonstrate an Intrusion Detection System (IDS) to detect suspicious activities and generate alerts when detected.

Mini Project (any one)

8. Mini Project 1: Implement Cross Site Scripting using stored attack. A stored cross-site scripting vulnerability in the comment functionality. [Note: To implement this assignment, submit a comment that calls the alert function when the blog post is viewed.]
9. Mini Project 2: Implement SQL injection vulnerability attack that causes the application to display details of all the products available on website.
10. Mini Project 3: Design the Access control vulnerability. [Note: This assignment has an unprotected admin panel. It is located at an unpredictable location, but the location is disclosed somewhere in the application. Use <https://portswigger.net>]
11. Mini Project 4: This task is to demonstrate insecure and secured website. Develop a web site and demonstrate how the contents of the site can be changed by the attackers if it is http based and not secured. You can also add payment gateway and demonstrate how money transactions can be hacked by the hackers. Then support your website having https with SSL and demonstrate how secured website is.

Learning Resources

Text Books:

1. Nina Godbole, Sunit Belapure, "Cyber Security- Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley India Pvt.Ltd., ISBN- 978-81-265-2179-1.
2. William Stallings, "Computer Security : Principles and Practices", Pearson 6thEd. ISBN :978-81-317-3351-6

Reference Books:

1. BerouzForouzan, "Cryptography and Network Security", 2nd Ed. TMH, ISBN: 9780070702080.
2. Mark Merkow, "Information Security-Principles and Practices", Pearson Ed. 978-81-317-1288-7.
3. CK Shyamala, "Cryptography and Security", Wiley India Pvt. Ltd, ISBN 978-81-265-2285-9

e-Books: https://heimdalsecurity.com/pdf/cyber_security_for_beginners_ebook.pdf**MOOC Courses:**

@The CO-PO mapping table

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

Part B : Elective II : Robotics and Automation**Prerequisite Courses, if any:****Companion Course, if any:****Course Objectives:**

- To study and survey recent trends in NLP
- To learn and implement different pre-processing techniques
- To design and develop different applications using NLP

Course Outcomes:

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

- CO1: Understand recent trends in NLP
 CO2: Implement different pre-processing techniques
 CO3: Design and develop various application using NLP

List of Assignments

1. Study Components of Industrial Robot (PUMA, KUKA, FANUC, Motomanetc) and its DH parameters.
2. Design and selection of Gripper / End effector
3. Two Programming exercise on lead through programming for Industrial Application
4. Program for Forward and Inverse kinematics of simple robot configuration (Robo Analyzer/ MATLAB or Open Source)
5. Control experiment using available Hardware or Software (Open Source or MATLAB)
6. Study of robotic system design.
7. Study of sensor integration.
8. Use of open source computer vision programming tool / Matlab, Open CV
9. Report on industrial application of robot /Industrial visit

Note: Choose any 4 assignments from Assignment 1 to Assignment 5 and any 1 assignment

form Assignment 6 to Assignment 9**Learning Resources****Text Books:**

1. Groover M.P.- Automation, production systems and computer integrated manufacturing' - Prentice Hall of India
2. John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009
3. R K Mittal & I J Nagrath, Robotics and Control, McGraw Hill Publication, 2015
4. Ganesh Hegde, Industrial Robotics, Laxmi publication
5. S. K. Saha, Introduction to Robotics, TMH International
6. Groover, Industrial Robotics, Tata McGraw-Hill Education

Reference Books:

1. Mark W Spong, M. Vidyasagar, Robot Dynamics And Control, John Wiley & Sons
2. Richard D. Klafter, Robotics Engineering: An Integrated Approach, Pearson

@The CO-PO mapping table

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

Part B : Elective II : Natural Language Processing**Prerequisite Courses, if any: Discrete Mathematics , Data Structure ,Artificial Intelligence****Companion Course, if any: Artificial Neural Network****Course Objectives:**

- To study and survey recent trends in NLP
- To learn and implement different pre-processing techniques
- To design and develop different applications using NLP

Course Outcomes:

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

CO1: Understand recent trends in NLP

CO2: Implement different pre-processing techniques

CO3: Design and develop various application using NLP

List of Assignments**1] Survey of Recent Advances in NLP:**

Detailed survey of recent efforts being taken in the field of NLP with respect to approaches, applications, problems etc.

2] To perform various preprocessing tasks in NLP:

Perform various basic pre-processing tasks like tokenization, stemming, lemmatization, stop word removal etc. using inbuilt functions and using regular expressions.

3] Perform Spelling Correction:

Apply minimum edit distance between two strings for spelling correction.

4] Implement a system to detect different types of toxicity like threats, obscenity, insults, and identity-based hate from comments. (Dataset: Wikipedia comments which have been labeled by

human raters for toxic behavior. you can download dataset from <https://www.kaggle.com/competitions/jigsaw-toxic-comment-classification-challenge/data>)

5] Recommendation system using Voice Chabot. (Use of Google speech engine)

6] Examiner less oral examination system (Speech to text and answer matching)

Note: Assignments 1-4 are mandatory. Perform any 1 from 5, 6.

Learning Resources

Text Books:

1. Steven Bird,Ewan Klein and EdwardLoper," NLP with Python:Analyzing text with the Natural Language Toolkit", O'Reilly Media,Inc

Reference Books:

1. Steven Bird,Ewan Klein and EdwardLoper," NLP with Python:Analyzing text with the Natural Language Toolkit", O'Reilly Media,Inc.
2. Nitin Indurkhy and Fred J. Dameau, "Handbook of Natural Language Processing", 2nd ed. CRC press.

e-Books:

1. Yoav Goldberg. A primer on neural network models for natural language processing, 2015. URL <http://u.cs.biu.ac.il/~yogo/nnlp.pdf>

MOOC Courses:

@The CO-PO mapping table

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

Part B : Elective II : Cloud Computing

PrerequisiteCourses,ifany:Database Management System (310241)

CompanionCourse,ifany:

Course Objectives:

- To Learn AWS environment.
- To Learn Amazon RDS.
- To design and develop different applications using Amazon Services.

Course Outcomes:

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

CO1: Understanding of AWS environment.

CO2: Understand Amazon RDS

CO3: Understand and use of AWS Lightsail

List of Assignments

1. Setting up AWS Environment: Create a new AWS account, Secure the root user, Create an IAM user to use in the account Set up the AWS CLI, Set up a Cloud9 environment.
2. Setup, Create and visualize data in an Amazon Relational Database (Amazon RDS) MS SQL Express server using Amazon Quick Sight.

3. Setup, Create and connect your Word Press site to an object storage bucket using Lightsail service.

Note: All assignments are mandatory.

Part B : Elective II : Software Modeling and Architecture

Prerequisite Courses, if any: Object Oriented Programming (210243), Software Engineering (210253)

Companion Course, if any: Software Modeling and Architecture

Course Objectives:

- To understand Software Modeling and Architecture
- To Use tools and techniques of Software Modeling and Architecture
- To Design and develop applications using UML
- To Apply the knowledge of Software Modeling and Architecture for problem solving

Course Outcomes:

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

CO1: Use tools and techniques of Software Modeling and Architecture

CO2: Apply the knowledge of Software Modeling and Architecture for problem solving

CO3: Design and develop applications using UML

List of Assignments

Select a moderately complex system which has at least 4-5 major functionalities. Identify stakeholders. Actors and write detail problem statement for your system. Implement following scenarios by taking reference of design model implementation using suitable object-oriented language.

1. Prepare Use Case Model
2. Draw detail use case diagram using UML 2.0 notations
3. Draw activity diagram with swim lanes using UML 2.0 Notations for major Use Cases
4. Prepare analysis model-class model
5. Draw sequence diagram for every scenario by using advanced notations using UML 2.0 (Identify at least 5 major scenarios (sequence flow) for your system)
6. Prepare Object Diagram, Package Diagram, Component diagram, Development diagram
7. Specify and document the architecture and design pattern with the help of templates.
Implement the system features and judge the benefits of the design patterns accommodated.

Learning Resources

Text Books:

1. Jim Arlow, Ilia Neustadt, "UML 2 and the unified process—practical object-oriented analysis and design", Addison Wesley, Second edition, ISBN 978-0201770605
2. Len Bass, Paul Clements, Rick Kazman, "Software Architecture in Practice", Second Edition, Pearson, ISBN 978-81-775-8996-2
3. Hassan Gomaa, "Software Modeling and Design- UML, Use cases, Patterns and Software Architectures", Cambridge University Press, 2011, ISBN 978-0-521-76414-8
Erich Gamma, "Design Patterns", Pearson, ISBN 0-201-63361-2

References Books:

1. Gardy Booch, James Rumbaugh, Ivar Jacobson, "The unified modeling language user guide",

Pearson Education, Second edition, 2008, ISBN 0-321-24562-8.

2. Ian Sommerville, "Software Engineering", 9th edition, ISBN-13: 978-0-13-703515-1 ISBN-10: 0-13-703515-2.

e-Books:

- <https://dhomaseghanshyam.files.wordpress.com/2016/02/gomaa-softwaremodellinganddesign.pdf>

MOOC Courses:

@The CO-PO mapping table

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



SavitribaiPhule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317537(A): Audit Course6
AC6-A: Digital and Social Marketing

Prerequisite Courses: Internet Technologies

Course Objectives:

- To understand the importance of digital marketing
- To understand the social media marketing
- To understand the effective marketing strategies and ways

Course Outcomes:

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

CO1: Understand the importance and fundamentals of digital marketing

CO2: Understand how the social media can be used for marketing

CO3: Analyze the effectiveness of digital marketing and social media over traditional process

Course Contents

1. Why you want to go digital?
2. Introduction to digital marketing
3. Content creation and sharing: Modern Website Creation
4. Digital privacy and Data security
5. Social media marketing
6. Email marketing
7. Online advertising
8. Mobile marketing
9. Web analytics for optimization

Learning Resources

Reference Books:

3. Avery Swartz, "See You on the Internet: building your small business with Digital Marketing", ISBN 978-1-989603-08-6
4. Damiyan Ryan, "Understanding Digital Marketing: Marketing strategies for engaging the digital generation", ISBN: 978 0 7494 6968 9

e-Books: --

MOOC Courses: --

@The CO-PO mapping table

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



Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317537(B): Audit Course6
AC6-B: Sustainable Energy Systems

Prerequisite: General awareness of environment and natural resources of energy

Course Objectives:

- To understand the importance of sustainable energy systems development
- To create awareness about renewable energy sources and technology
- To learn about adequate inputs on a variety of issues in harnessing renewable energy
- To recognize current and possible future role

Course Outcomes:

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

CO1: Understand the importance of Sustainable Energy Systems

CO2: Develop the awareness towards Sustainable Energy Systems protection

CO3: Know different types of natural resource pollution

CO4: Develop the awareness towards the exploitation and utilization of conventional and non-conventional energy resources

Course Contents

1. **Energy resources and their utilization:** Conservation and forms of energy, Electric energy from conventional sources, Renewable energy sources
2. **Environmental aspects of electric energy generation:** Atmospheric pollution, Thermal pollution, Disposal of waste, Global environmental awareness, Impact of renewable energy generation on environment
3. **Solar thermal energy conversion systems:** Solar radiation and its measurement, Solar water heating, Solar thermal power plants, Solar ponds, Solar pumping systems, Solar air heaters, Solar crop drying, Solar cookers, Energy efficient buildings, Solar greenhouses
4. **Wind Energy:** Power in the Wind, Wind characteristics, Types of Wind Power Plants (WPPs), Components of WPPs, and Working of WPPs.

Learning Resources

Reference Books:

- 1.D.P.Kothari, K.C Singal, Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt.Ltd, New Delhi, 2013.
2. Joshua Ernest, Tore Wizeliu, "Wind Power Plants and Project Development", PHI Learning Pvt.Ltd, New Delhi, 2011.
3. A.K.Mukerjee and Nivedita Thakur, "Photovoltaic Systems: Analysis and Design", PHI Learning Private Limited, New Delhi, 2011

@The CO-PO mapping table

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

Home

Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317537(C): Audit Course6
AC6-C: Leadership and Personality Development

Prerequisite: General awareness of communication and relationship

Course Objectives:

- To create awareness about importance of personality development
- To improve soft skills and communication skills
- To develop interpersonal skills and ability to work effectively in a team
- To create awareness about importance of body language to reveal inner self and personality
- To develop professionals with leadership qualities

Course Outcomes:

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

CO1: Explore as an individual as well as a team member

CO2: Express effectively through communication and improve interpersonal skills

CO3: Develop effective team leadership abilities

CO4: Work effectively in heterogeneous teams through the knowledge of team work, interpersonal skills and leadership qualities

Course Contents

1. Personality Development: A Must for Leadership and Career Growth

Personality Analysis, Swami Vivekananda's Concept of Personality Development: Physical Self, Energy Self, Intellectual Self, Mental Self, Blissful Self; Interpersonal Skills: Resolving Conflict, A Smiling Face, Appreciative Attitude, Assertive Nature, Communication Skills, Listening Skills, Developing Empathy; The Personality Attribute of Taking Bold Decisions; Personality Types and Leadership Qualities: Mapping the Different Personality Types, Perfectionists, Helpers, Achievers, Romantics, Observers, Questioners, Enthusiasts or Adventurers, Bosses or Asserters, Mediators or Peacemakers

2. Soft Skills: Demanded by Every Employer

Change in Today's Workplace: Soft Skills as a Competitive Weapon, Classification of Soft Skills: Time Management, Attitude, Responsibility, Ethics, Integrity, Values, and Trust, Self-confidence and Courage, Consistency and Predictability, Teamwork and Interpersonal Skills, Communication and Networking, Empathy and Listening Skills, Problem Solving, Troubleshooting and Speed-reading and Leadership

3. Communication Skills

Speaking Skills, Phonetics, Accent, Intonation, Writing Skill to Create an Impression: Your Résumé or Curriculum Vitae, Writing a Modern Résumé

4. Group Discussion: A Test of Your Soft Skills

Ability to Work as a Team, Communication Skills, Including Active Listening, Non-verbal Communication, Leadership and Assertiveness, Reasoning, Ability to Influence, Innovation, Creativity and Lateral Thinking, Flexibility

5. Job Interviews: Gateway to the Job Market

Types of Interviews, Abide by the Dress Code, Importance of Body Language in Interviews, Telephonic or Video Interview—A Growing Trend

6. Body Language: Reveals Your Inner Self and Personality

Emotions Displayed by Body Language: Aggressive, Submissive, Attentive, Nervous, Upset, Bored, Relaxed, Power, Defensive; Handshake—The Most Common Body Language, Eyes—A Powerful Reflection of One's Inner Self

Learning Resources

Reference Books:

1. Barun K Mitra, (2011), "Personality Development and Soft skills", First Edition, Oxford Publishers, ISBN: 780199459742, ISBN: 0199459746
2. Urmila Rai and S.M. Rai, "Business Communication", Himalay Publication House
3. Shiv Khera, "You Can Win", A&C Black, ISBN: 9780230331198
4. Dale Carnegie, "How to win Friends and Influence People", New York: Simon & Schuster,

1998, ISBN: 1-4391-6734-6

5. Paul Sloane, “The Leader's Guide to Lateral Thinking Skills Unlocking the Creativity and Innovation in You and Your Team”, 2006
6. Ronald Bennett, Elaine Millam, “Leadership for engineers : the magic of mindset”
7. Baron R, Byrne D, Branscombe N, BharadwajG (2009), “Social Psychology, Indian adaptation” , Pearson , New Delhi
8. Baumgartner S.R, Crothers M.K. (2009) “Positive Psychology”, Pearson Education

@The CO-PO mapping table

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

SavitribaiPhule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317537(D): Audit Course6
AC6-D: Foreign Language(Japanese)-Module 3

Prerequisite Courses: We recommend that candidates should have previously completed AC3-V(217527-V), AC4-V (217535-V) and AC5-IV (317531)

Course Objectives:

- To open up more doors and job opportunities
- To introduce to Japanese society, culture and entertainment

Course Outcomes:

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

- CO1: Apply language to communicate confidently and clearly in the Japanese language
- CO2: Understand and use Japanese script to read and write
- CO3: Apply knowledge for next advance level reading, writing and listening skills
- CO4: Develop interest to pursue further study, work and leisure

Course Contents

1. The Kanji: Brief Historical Outline, Introduction to Kanji, From Pictures to characters
2. Read and Write 58 Kanji Characters, talk about yourself/family/others, things, time, events, and activities-in the present, future, and past tense; shop at stores and order food at restaurants;
3. Lessons: Karate, Park(Playground), The Grandpa's Inaka, The Sun and the Moon, My littlesister, Rice Fields, My Teacher, People who Exit and People who Enter.

Learning Resources

Reference Books:

1. Banno, Eri, Yoko Ikeda, et al. Genki I, "An Integrated Course in Elementary Japanese", 2nded. Japan Times/Tsai Fong Books, 2011. ISBN: 9784789014403
2. Anna Sato and Eriko Sato, "My First Japanese Kanji Book, Learning kanji the fun and easyway", TUTTLE PUBLISHING, First Edition ISBN: 978-1-4629-1369-5 (eBook)

e-Books:

- Japanese Kanji and Kana,"A complete guide to the Japanese writing system", Wolfgang Hadamitzky& Mark Spahn, Tuttle Publishing, Third edition ISBN: 978-1-4629-1018-2

MOOC Courses:

@The CO-PO mapping table

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



Savitribai Phule Pune University
Third Year of Artificial Intelligence and Data Science (2019 Course)
317537(E): Audit Course6
AC6-E: MOOC- Learn New Skills

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives:

- To promote interactive user forums to support community interactions among students, professors, and experts
- To promote students to learn additional skills anytime and anywhere
- To enhance teaching and learning on campus and online
- To motivate students for self-learning useful for advancing their career

Course Outcomes:

CO1: On completion of the course, learner will acquire additional knowledge and skill.

Course Contents

MOOCs (Massive Open Online Courses) provide affordable and flexible way to learn new skills, pursue lifelong interests and deliver quality educational experiences at scale. It helps you to learn for yourself, to advance your career or leverage online courses to educate your workforce. Platforms such as SWAYAM, NPTEL, edx or similar ones can help for self-learning.

World's largest SWAYAM MOOCs is a new paradigm of education for anyone, anywhere, anytime, as per your convenience. It aims to provide digital education free of cost and facilitate hosting of all the interactive courses prepared by more than 1000 specially chosen the best faculty and teachers in the country. SWAYAM MOOCs enhance active learning for improving lifelong learning skills by providing easy access to global resources.

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. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have remained untouched so far by the digital revolution and have not been able to join the mainstream of the knowledge economy.

This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere, at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses.

The courses hosted on SWAYAM is generally in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology. In order to ensure best quality content are produced and delivered, seven National Coordinators have been appointed: They are NPTEL for engineering and UGC for post-graduation education.

Guidelines:

Instructors are requested to promote students to opt for courses (not opted earlier) with proper mentoring. The departments will take care of providing necessary infrastructure and facilities for the learners.

Learning Resources

References:

1. <https://swayam.gov.in/>
2. <https://onlinecourses.nptel.ac.in/>
3. <https://www.edx.org>

MOOC Courses:

@The CO-PO mapping table

*Mapping will vary according to the course selected.

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												

Acknowledgement

It is with great pleasure and honor that I share the curriculum for Third Year of Artificial Intelligence and Data Science (2019 Course) on behalf of Board of Studies (BoS), Computer Engineering. We, members of BoS are giving our best to streamline the processes and curricula design at both UG and PG programs.

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

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

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

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

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

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

Special thanks are due to **Mr. Vijay Kharat** for his efforts in assembling the draft. I would like to thank you from the core of my heart. Thank you for always being your best selves and contributing to the work.

I am thankful to **Dr. S. V. Gumaste** and **Dr. Swati Bhavsar** for the time they have spent in critically reading the draft and giving the final touches. I appreciate their initiative and thank them for the time, patience and hard work!

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

Thank you for all your efforts!

Professor (Mrs.) Dr. Varsha H. Patil, Chairman, and

Members- Dr. Shirish Sane, Dr. Sunil Bhirud, Dr. Manik Dhore, Dr. Pramod Patil, Dr. Girish Khilari, Dr. Sachin Lodha, Dr. Parikshit Mahalle, Dr. Venkatesharan, Dr. Geetanjali Kale, Dr. Suhasini Itkar, Dr. R. V. Patil, Dr. P. M. Yawalkar and Dr. Swati Bhavsar.

Task Force at Curriculum Design



1. Advisors, the Team of Board of Studies-

Dr. Varsha Patil (Chairman), Dr. Shirish Sane, Dr. Sunil Bhirud, Dr. Manik Dhore, Dr. Girish Khilari, Dr. Sachin Lodha, Dr. Parikshit Mahalle, Dr. Pramod Patil, Dr. Venkatesharan, Dr. Geetanjali Kale, Dr. Suhasini Itkar, Dr. R. V. Patil, Dr. P. M. Yawalkar and Dr. Swati Bhavsar.

2. Team Leader-Dr. Prashant M. Yawalkar

3. Teams, Course Design-

NameofCourse	Team Coordinator	TeamMembers	
Database Management Systems	Dr. Anuradha Thakare	Dr.Sarika Nitin Zaware Dr. S. B. Tambe Prof. Ranjit M. Gawande	Prof. Rahul Patil Prof. Prashant Ahire Dr. Sharmila Wagh
Computer Networks	Dr. Amol Potgantwar	V. D. Dabhade Radhika Adki Tushar Kute (Industry)	Dr. A.V. Dhumane Dr. Vinod V. Kimbahune Poonam Patil
Web Technology	Prof. Abhijit D. Jadhav	Prof. Jayvant Devare	Mr. Avinash Patil (Industry) Mr. Saikrishna Mamidishetty (Industry)
Artificial Intelligence	Dr. J. R. Prasad	Dr. Gayatri M. Bhandari Dr. V. P. Vikhe Dr. Snehal Mohan Kamalapur	Dr. K Rajeswari Dr.Mrs.Madhuri Pote
Elective I: Embedded Systems and Security	Dr. R. K Agrawal	Dr. P. N. Metange Dr. Bage Prashant Salunke (Industry)	Dr.Sandeep Chaware Santosh Kumar Sayali Belhe
Elective I: Human Computer Interface	Dr. S. D. Babar	Prof. Mrs. G. J. Chhajed Prof. D.D.Sapkal Prof. Mrs.Jayshree R. Pansare Mr. Mukesh Jain (Industry) Prof. Mrs. Shailaja N. Lohar	Prof. S. A. Thanekar Dr.Deepak Dharrao Dr. Ganesh Bhutkar Mr. Himmat Sankhala (Industry)
Elective I: Pattern Recognition	Dr. S. A. Sonkar	Dr. Prachi Joshi	Dr. Swati A. Bhavsar Dr. Sonali Patil Dr. Rachna Somkunwar Mr. Vijay Bahiraji (Industry)
Elective I: Design Thinking	Dr. K. S. Wagh	Dr. Limkar S. V. Sanjay Agrawal	Dr. S. K. Pathan Dr. Amol Dhumne
Software Laboratory I	Prof V. D. Dabhade	Prof. V. B. More	Prof V. D. Patil
CN Laboratory	Dr. Amol Potgantwar	V. D. Dabhade Radhika Adki	Tushar Kute (Industry)
Elective I Laboratory	Dr. N. A. Deshpande	Dr. K. S. Wagh Dr. R. K. Agrawal Dr. S. K. Pathan Dr. Vinay Kottawar	Dr. S. K. Sonkar Dr. Swati Bhavsar Shwetali Patil
Seminar and Technical Communication	Prof Shailendra Vidhate	Dr. Swati A. Bhavsar Mr. S. S. Chaudhari	Mr. Rushikesh Jadhav (Industry) Mr. Manoj Suri
Audit Course 5	Dr. Vaishali Tidke	Prof Dhande	Dr. Sandeep Patil



			Mr. B. B. Gite
Environmental Studies	Dr. Manoj Wakchaure	Dr. Saner Prof Wagh	
Data Science	Dr. D. V. Patil	Dr. Mahesh Sanghvi Dr. K. Sujatha Rao Mr. Manoj Bhatkar (Industry)	Archana Banait I Priyadarshini
Cyber Security	Prof V. D. Dabhade	Dr. P. N. Metange Dr Swati Nikam D. M. Kanade	Dr. M. A. Jawale Dr. Swapnaja Ubale N. V. Sharma
Artificial Neural Network	Dr. Shraddha Pandit	Dr. Aradhana Deshmukh Suvarna Patil Dr. P. N. Kalavadekar	Tejashri Kore Sunita Borse
Elective II: Robotics and Automation	Dr. N. R. Wankhede	Dr. Kushare P. B Dr. Chougule V. N	Dr.P. R. Hatte.
Elective II: Natural Language Processing	Dr. P. N. Kalavadekar	Dr. Mubin Tamboli Dr. Suvarna Bhagwat	Mr. Arpit Yadav (Industry)
Elective II: Cloud Computing	Dr. S. K. Sonkar	Prof. Abhijit D. Jadhav Dr. Pankaj Agarkar Dr. N. M. Ranjan	Dr. A. S. Rumale Prof. Thombre B. H. Mr.Ashok Pomnar (Industry) Mr.Santosh Ugale (Industry)
Elective II: Software Modeling and Architectures	Dr M A Pradhan	Prof. Mrs. Dipalee Divakar Rane Prof Jyoti Kulkarni	Dr. Neeta Deshpande Prof . Nareshkumar Mustary Dr Aarti D K
Internship	Dr. Kalpana V. Metre	Dr. Geetanjali Kale Mahendra Jagtap	Padulkar
Software Laboratory-II	Suvarna Patil	Dr. Shraddha Pandit S. G. Rathod	Swapnil Chaudhari Yogesh Murumkar
Software Laboratory III	Sneha Salvekar	Dr. D. V. Patil D. J. Bonde	Dr. Mahesh Sanghvi
Mini Project	Dr. M. A. Jawale	Dr. Swapnaja Ubale N. V. Sharma	D. M. Kanade
Audit Course 6	Dr. Tidake Vaishali	Dr. S. S. Das	Dhande Prof. Abhijit D. Jadhav

[Back to Table of Contents](#)

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



<http://unipune.ac.in>

**Curriculum
For
Fourth Year of Artificial Intelligence and Data
Science (2020 Course)
(With effect from A.Y. 2023-24)**

**Final Year of Artificial Intelligence and Data Science Engineering
(2020 Course)
(With effect from 2023-24)**

Prologue

B.E. (Artificial Intelligence and Data Science) course began in the Academic Year 2020-21 with 15 institutes taking part in this course in Savitribai Phule Pune University. It is a great privilege to design and share the syllabi for Fourth year of Artificial Intelligence and Data Science (2020 course) on the behalf of Board of Studies (Computer Engineering).

Honest and sincere efforts have been put in by us to frame the syllabus in accordance with NEP recommendations, AICTE, UGC and affiliated University (SPPU) and while taking in consideration the technological advancements and industrial requirements.

Our team of faculty members and several industry domain professionals have given their valuable time towards reviewing the work to get its final shape. Nearly all courses have case studies and the course instructor has been recommended to discuss suitable current technology/ upgrades / case studies to encourage students to think about the developments /ongoing trends / issues /utilities in the real world and study the course from a scenario.

I am beholder to all the minds and hands who have worked adroitly to execute these tasks. I am highly appreciative of your contributions and suggestions given to this content.

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

Links to SE, TE (AIDS) Syllabus

SE : http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2021/SE_AI-DS_Curriculum_2021_28.06.2021.pdf

TE : http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2022/TE_17012023.zip

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
(With effect from Academic Year 2023-24)

Table of Contents

Sr. No.	Title	Page Number
1.	Program Outcomes	5
2.	Program Specific Outcomes	5
3.	Course Structure	6-7
4.	General Guidelines	8-9
	Course Contents (Semester VII)	
5.	417521: Machine Learning	11
	417522: Data Modeling & Visualization	15
	417523A: Quantum Artificial Intelligence	19
	417523B: Industrial Internet of Things	22
	417523C: Enterprise Architecture and Components	26
	417523D: Bioinformatics	28
	417524A: GPU Programming and Architecture	31
	417524B: Information Retrieval	34
	417524C: UI/UX Design	37
	417524D: Optimization Algorithms	40
	417525: Computer Laboratory I	43
	417526: Computer Laboratory II	50
	417527: Project Stage I	66
	417528: MOOC	67
Audit Course 7	69	
	Course Contents (Semester VIII)	
6.	417530: Computational Intelligence	77
	417531: Distributed Computing	80
	417532A: Virtual Reality and Game Development	84
	417532B: Big Data analytics	87
	417532C: Software Development for Portable Devices	90
	417532D: Deep Learning	94
	417533A: Augmented Reality	97
	417533B: Business Intelligence	100
	417533C: Information Systems Management	103
	417533D: Reinforcement Learning	106
	417534: Computer Laboratory III	109

	417535: Computer Laboratory IV	112
	417536: Project Stage II	118
	Audit Course 8	119
	Acknowledgments	115

Savitribai Phule Pune University
Bachelor of Engineering in Artificial Intelligence and 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 practice.
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 the 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 the 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)

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
(With effect from Academic Year 2023-24)

Semester-VII

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/Presentation	Total	Lecture	Practical	Tutorial
417521	Machine Learning	03	-	-	30	70	-	-	-	100	03	-	-
417522	Data Modeling & Visualization	03	-	-	30	70	-	-	-	100	03	-	-
417523	Elective III	03	-	-	30	70	-	-	-	100	03	-	-
417524	Elective IV	03	-	-	30	70	-	-	-	100	03	-	-
417525	Computer Laboratory I	-	04	-	-	-	50	25	-	75	-	02	-
417526	Computer Laboratory II	-	04	-	-	-	50	25	-	75	-	02	-
417527	Project Stage I	-	04	-	-	-	50	-	50	100	-	02	-
417528	MOOC	-	-	02	-	-	50	-	-	50	-	-	02
	Total	12	12	02	120	280	200	50	50	700	12	06	02
417529	Audit Course 7												Total Credits
											12	06	02
													20

Elective III:

- 417523(A) Quantum Artificial Intelligence
- 417523(B) Industrial Internet of Things
- 417523(C) Enterprise Architecture and Components
- 417523(D) Bioinformatics

Elective IV:

- 417524(A) GPU Programming and Architecture
- 417524(B) Information Retrieval
- 417524(C) UI/UX Design
- 417524(D) Optimization Algorithms

Computer Laboratory I:

It is based on two compulsory subjects:

- Machine Learning
- Data Modeling & Visualization

Computer Laboratory II:

It is based on two Elective subjects:

- Elective III
- Elective IV

Audit Course 7:

AC7 – I Block Chain

AC7 – II Entrepreneurship Development

AC7 – III Botnet of Things

AC7 – IV Foreign Language

AC7 – V MOOC-Learn New Skills

Savitribai Phule Pune University Fourth Year of Artificial Intelligence and Data Science (2020 Course) (With effect from Academic Year 2023-24)														
Semester-VIII														
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/ Presentation	Total	Lecture	Practical	Tutorial	Total
417530	Computational Intelligence	03	-	-	30	70	-	-	-	100	03	-	-	03
417531	Distributed Computing	03	-	-	30	70	-	-	-	100	03	-	-	03
417532	Elective V	03	-	-	30	70	-	-	-	100	03	-	-	03
417533	Elective VI	03	-	-	30	70	-	-	-	100	03	-	-	03
417534	Computer Laboratory III	-	02	-	-	-	50	25	-	75	-	01	-	01
417535	Computer Laboratory IV	-	02	-	-	-	50	25	-	75	-	01	-	01
417536	Project Stage II	-	12	-	-	-	100	-	50	150	-	06	-	06
	Total	12	16	-	120	280	200	50	50	700	12	08	-	20
417537	Audit Course 8													
		Total Credits												
		12	08	-										20
Elective V: 417532(A) Virtual Reality and Game Development 417532(B) Big Data analytics 417532(C) Software Development for Portable Devices 417532(D) Deep Learning		Elective VI: 417533(A) Augmented Reality 417533(B) Business Intelligence 417533(C) Information Systems Management 417533(D) Reinforcement Learning												
Computer Laboratory III: It is based on two compulsory subjects: <ul style="list-style-type: none">• Computational Intelligence• Distributed Computing		Computer Laboratory IV: It is based on two Elective subjects: <ul style="list-style-type: none">• Elective V• Elective VI												
Audit Course 8: AC8 – I Usability Engineering AC8 – II Conversational Interfaces AC8 – III Social Media and Analytics AC8 – IV Foreign Language AC8 – V MOOC-Learn New Skills														

General Guidelines

1. Every undergraduate program has its own objectives and educational outcomes. These objectives and outcomes are furnished by considering various aspects and impacts of the curriculum. These **Program Outcomes (POs)** are categorically mentioned at the beginning of the curriculum (ref: NBA Manual). There should always be a rationale and a goal behind the inclusion of a course in the curriculum. Course Outcomes though highly rely on the contents of the course, many a times are generic and bundled. The **Course Objectives, Course Outcomes** and **CO-PO mappings matrix** justifies the motives, accomplishment and prospect behind learning the course. The Course Objectives, 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. **CO and PO Mapping Matrix** (Course Objectives and Program Outcomes) attainment mapping matrix at end of course contents, indicates the correlation levels of 3, 2, 1 and —. The notation of 3, 2 and 1 denotes substantially (high), moderately (medium) and slightly (low). The mark — indicates that there is no correlation between CO and PO.
3. For each course, contents are divided into six units-I, II, III, IV, V and VI.
#Elaborated examples/Case Studies are included at each unit to explore how the learned topics apply to real world situations and need to be explored so as to assist students to increase their competencies, inculcating the specific skills, building the knowledge to be applicable in any given situation along with an articulation. One or two sample exemplars or case studies are included for each unit; instructor may extend the same with more. Exemplar/Case Studies may be assigned as self-study by students and to be excluded from theory examinations.
4. *For each unit contents, the content attainment mapping is indicated with Course Outcome(s). Instructor may revise the same as per their viewpoint.
5. For laboratory courses, set of suggested assignments is provided for reference. Laboratory Instructors may design suitable set of assignments for respective course at their level. Beyond curriculum assignments and mini-project may be included as 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.
6. For each laboratory assignment, it is essential for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorial may be as per guidelines of authority.
7. For each course, irrespective of the examination head, the instructor should motivate students to read articles/research papers related to recent development and invention in the field.
8. For laboratory, instructions have been included about the conduction and assessment of laboratory work. These guidelines are to be strictly followed.
9. **Term Work** –Term work is continuous assessment that evaluates a student's progress throughout the semester. Term work assessment criteria specify the standards that must be met and the evidence that will be gathered to demonstrate the achievement of course outcomes. Categorical assessment criteria for the term work should establish unambiguous standards of achievement for each course outcome. They should describe what the learner is expected to perform in the laboratories or on the fields to show that the course outcomes have been achieved.

Students' work will be evaluated typically based on the criteria like attentiveness, proficiency

in execution of the task, regularity, punctuality, use of referencing, accuracy of language, use of supporting evidence in drawing conclusions, quality of critical thinking and similar performance measuring criteria.

10. Program codes with sample output of all performed assignments are to be submitted as softcopy. Use of DVD or similar media containing students' programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at 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. (In laboratory Practices the lab teachers can give different applications other than the indicated.)

Abbreviations

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

Semester VII

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417521: Machine Learning

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
---	----------------------------	---

Prerequisites Courses: Data Science (317529), Artificial Neural Network (317531)

Course Objectives:

- Explain the learning paradigms, and models of machine learning
- Apply different regression techniques for making predictions in different applications
- Apply the classification algorithms to classify the data with appropriate labels
- Apply the clustering algorithms to divide the unlabeled data into the similar groups
- Introduce and integrate models in the form of advanced ensembles
- Explain reinforcement learning and its algorithms

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Describe and compare different models of machine learning

CO2: Design ML models to make predictions by using linear, non-linear and logistic regression techniques

CO3: Implement classification models for two class problems and multiclass problems

CO4: Implement clustering models for unlabeled data

CO5: Integrate multiple machine learning algorithms in the form of ensemble learning

CO6: Apply reinforcement learning and its algorithms for different applications

Course Contents

Unit I	Introduction to Machine Learning	06 Hours
Introduction: What is Machine Learning, Definitions and Real-life applications, Comparison of Machine learning with traditional programming, ML vs AI vs Data Science.		
Learning Paradigms: Learning Tasks- Descriptive and Predictive Tasks, Supervised, Unsupervised, Semi-supervised and Reinforcement Learnings.		
Models of Machine learning: Geometric model, Probabilistic Models, Logical Models, Grouping and grading models, Parametric and non-parametric models.		
Feature Transformation: Dimensionality reduction techniques- PCA and LDA		
#Exemplar/Case Studies	<p>Explore the machine learning paradigms with its application: This case study is about exploring three different machine learning paradigms that help to solve different problem categories in plain language and from a technical standpoint.</p> <p>Reference URL: https://www.analyticsvidhya.com/blog/2022/07/machine-learning-paradigms-with-example/</p>	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Regression	06 Hours

Introduction- Regression, Need of Regression, Difference between Regression and Correlation, Types of Regression: Univariate vs. Multivariate, Linear vs. Nonlinear, Simple Linear vs. Multiple Linear, Bias-Variance tradeoff, Overfitting and Underfitting.

Regression Techniques - Polynomial Regression, Stepwise Regression, Decision Tree Regression, Random Forest Regression, Support Vector Regression, Ridge Regression, Lasso Regression, ElasticNet Regression, Bayesian Linear Regression.

Evaluation Metrics: Mean Squared Error (MSE), Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), R-squared, Adjusted R-squared.

#Exemplar/Case Studies	Comparison of different regression models: Build and compare the Lasso, Ridge, and Elastic Net regression models, consider the big market sales to predict sales depending on features selected. This case study discusses regression models and how they can be used to solve prediction problems. Reference URL: https://www.analyticsvidhya.com/blog/2017/06/a-comprehensive-guide-for-linear-ridge-and-lasso-regression/
*Mapping of Course Outcomes for Unit II	CO2

Unit III	Classification	06 Hours
Introduction: Need of Classification, Types of Classification (Binary and Multiclass), Binary-vs-Multiclass Classification, Balanced and Imbalanced Classification Problems.		
Binary Classification: Linear Classification model, Performance Evaluation- Confusion Matrix, Accuracy, Precision, Recall, F measures.		
Multiclass Classification: One-vs-One and One-vs-All classification techniques, Performance Evaluation- Confusion Matrix, Per Class Precision, Per Class Recall		
Classification Algorithms: K Nearest Neighbor, Linear Support Vector Machines (SVM) – Introduction, Soft Margin SVM, Kernel functions– Radial Basis Kernel, Gaussian, Polynomial, Sigmoid.		

#Exemplar/Case Studies	Explore Multiclass Classification with imbalanced dataset: This case study uses a “20 Newsgroups” data set that is converted into an imbalanced form. A multiclass classification algorithm is applied on an imbalanced dataset and its performance is compared with the model after applying undersampling/oversampling techniques. Reference URL: https://builtin.com/machine-learning/multiclass-classification
*Mapping of Course Outcomes for Unit III	CO3

Unit IV	Clustering	06 Hours
Introduction: What is clustering, Need of Clustering, Types of Clustering		
Hierarchical clustering algorithms /connectivity-based clustering): Agglomerative Hierarchical Clustering (AHC) algorithm, Divisive Hierarchical Clustering (DHC) algorithm.		
Centroid-based clustering algorithms / Partitioning clustering algorithms: K-Means clustering algorithm, Advantages and disadvantages of K-Means clustering algorithm, Elbow method, The Silhouette method, K-Medoids, K-Prototype.		
Density-based clustering algorithms: DBSCAN algorithm, how it works, Advantages and disadvantages of DBSCAN.		
Distribution-based clustering algorithms: Gaussian mixture model.		
Application of Clustering Technique: Market Segmentation, Statistical data analysis, Social network analysis, Image segmentation, Anomaly detection.		

#Exemplar/Case Studies	Customer segmentation using clustering algorithms: This case study demonstrates the concept of segmentation of a customer data set from an e-commerce site using k-means clustering in python. The data set contains the annual income of ~300 customers and their annual spend on an e-commerce site. The k-means clustering algorithm is applied to derive the optimum number of clusters and understand the underlying customer segments based on the data provided. Reference URL: https://towardsdatascience.com/clustering-algorithms-for-customer-segmentation-af637c6830ac	
	*Mapping of Course Outcomes for Unit IV	
Unit V	Ensemble Learning	06 Hours
<p>Ensemble Learning: Introduction to Ensemble Learning, Need of Ensemble Learning, Homogeneous and Heterogeneous ensemble methods, Advantages and Limitations of Ensemble methods, Applications of Ensemble Learning.</p> <p>Basic Ensemble Learning Techniques: Voting Ensemble, Types of Voting: Max Voting, Averaging, Weighted Average.</p> <p>Advanced Ensemble Learning Techniques:</p> <ul style="list-style-type: none"> Bagging: Bootstrapping, Aggregation. Boosting: Adaptive Boosting (AdaBoost), Gradient Boosting, XGBoost . Stacking: Variance Reduction, Blending, Random Forest Ensemble, Advantages of Random Forest. 		
#Exemplar/Case Studies	Apply ensemble learning techniques: This case study uses ensemble learning techniques on the Heart Attack dataset. It indicates that ensemble techniques, such as bagging and boosting, are effective in improving the prediction accuracy of weak classifiers and exhibit satisfactory performance in identifying risk of heart disease. Reference URL: https://www.sciencedirect.com/science/article/pii/S235291481830217X?via%3Dhub	
	*Mapping of Course Outcomes for Unit V	
Unit VI	Reinforcement Learning	06 Hours
<p>Reinforcement learning: What is Reinforcement Learning? Need for Reinforcement Learning, Supervised vs Unsupervised vs Reinforcement Learning, Types of Reinforcement, Elements of Reinforcement Learning, Real time applications of Reinforcement learning.</p> <p>Markov's Decision Process: Markov property, Markov chain/process, Markov reward process (MRP), Markov decision process (MDP), Return, Policy, Value functions, Bellman equation</p> <p>Q Learning: Introduction of Q-Learning, Important terms in Q learning, Q table, Q functions, Q learning algorithm.</p>		
#Exemplar/Case Studies	Implement Tic Tac Toe Game using reinforcement Learning: The case study explores the implementation of reinforcement learning techniques to create an agent capable of playing Tic-Tac-Toe. It discusses the use of Q-learning and the construction of a reward system to train the agent, resulting in a player that can learn and improve its gameplay over time. Reference URL: https://towardsdatascience.com/reinforcement-learning-implement-tictactoe-189582bea542	
	*Mapping of Course Outcomes for Unit VI	
	CO6	

Learning Resources

Text Books:

1. Ethem Alpaydin, "Introduction to Machine Learning", Publisher: The MIT Press,2014
2. Peter Flach: "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press, Edition 2012

Reference Books:

1. Ian H Witten, Eibe Frank, Mark A Hall, "Data Mining, Practical Machine Learning Tools and Techniques", Elsevier, 3rd Edition
2. Jiawei Han, Micheline Kamber, and Jian Pie, "Data Mining: Concepts and Techniques", Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807
3. Shalev-Shwartz, Shai, and Shai Ben-David, "Understanding machine learning: From theory to algorithms", Cambridge university press, 2014
4. McKinney, "Python for Data Analysis O'Reilly media, ISBN : 978-1-449- 31979-3

e-Resources:

1. <https://timeseriesreasoning.com/>
2. Reinforcement Learning: https://www.cs.toronto.edu/~urtasun/courses/CSC411_Fall16/19_rl.pdf
3. A brief introduction to machine learning for Engineers: <https://arxiv.org/pdf/1709.02840.pdf>
4. Introductory Machine Learning Nodes: <http://lcs.mit.edu/courses/ml/1718/MLNotes.pdf>

MOOC Courses:

1. Introduction to Machine Learning(IIT kharagpur) : <https://nptel.ac.in/courses/106105152>
2. Introduction to Machine Learning (IIT Madras):
https://onlinecourses.nptel.ac.in/noc22_cs29/preview
3. Machine Learning A-Z™: AI, Python & R + ChatGPT Bonus [2023]
<https://www.udemy.com/course/machinelearning/>
4. Machine Learning and Deep Learning A-Z: Hands-On Python
<https://www.udemy.com/course/machine-learning-and-deep-learning-a-z-hands-on-python/>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417522: Data Modeling and Visualization

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
---	----------------------------	---

Prerequisites Courses: Statistics (217528), Computer Graphics (210244), Database Management System (310241)

Course Objectives:

- Creating an emerging data model for the data to be stored in a database
- Conceptualized representation of Data objects
- Create associations between different data objects, and the rules
- Organize data description, data semantics, and consistency constraints of data
- Identifying data trends
- Incorporate data visualization tools and reap transformative benefits in their critical areas of operations

Course Outcomes:

After completion of the course, learners should be able to-

- CO1:** Summarize data analysis and visualization in the field of exploratory data science
CO2: Analyze the characteristics and requirements of data and select an appropriate data model
CO3: Describe to load, clean, transform, merge and reshape data
CO4: Design a probabilistic data modeling, interpretation, and analysis
CO5: Evaluate time series data
CO6: Integrate real world data analysis problems

Course Contents

Unit I	Introduction to Data Modelling	06 Hours
Basic probability: Discrete and continuous random variables, independence, covariance, central limit theorem, Chebyshev inequality, diverse continuous and discrete distributions.		
Statistics, Parameter Estimation, and Fitting a Distribution:	Descriptive statistics, graphical statistics, method of moments, maximum likelihood estimation	
Data Modeling Concepts	• Understand and model subtypes and supertypes • Understand and model hierarchical data • Understand and model recursive relationships • Understand and model historical data	
#Exemplar/Case Studies	Case study of sampling for any real-world problem like exit poll statistics	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Testing and Data Modeling	06 Hours
Random Numbers and Simulation: Sampling of continuous distributions, Monte Carlo methods Hypothesis Testing: Type I and II errors, rejection regions; Z-test, T-test, F-test, Chi-Square test, Bayesian test		
Stochastic Processes and Data Modeling: Markov process, Hidden Markov Models, Poisson Process, Gaussian Processes, Auto-Regressive and Moving average processes, Bayesian Network, Regression, Queuing systems		
#Exemplar/Case Studies	Hypothesis Testing for examples like: Dieters lose more fat than the exercisers, New medicine testing	

*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Basics of Data Visualization	06 Hours
Computational Statistics and Data Visualization , Types of Data Visualization, Presentation and Exploratory Graphics, Graphics and Computing, Statistical Historiography, Scientific Design Choices in Data Visualization , Higher-dimensional Displays and Special Structures, Static Graphics : Complete Plots, Customization, Extensibility, Other Issues : 3-D Plots, Speed, Output Formats, Data Handling		
#Exemplar/Case Studies	Use IRIS dataset from Scikit and plot 2D-3D views of the dataset	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Data Visualization and Data Wrangling	06 Hours
Data Wrangling : Hierarchical Indexing, Combining and Merging Data Sets Reshaping and Pivoting. Data Visualization matplotlib: Basics of matplotlib, plotting with pandas and seaborn, other python visualization tools Data Visualization Through Their Graph Representations : Data and Graphs Graph Layout Techniques, Force-directed Techniques Multidimensional Scaling, The Pulling Under Constraints Model, Bipartite Graphs		
#Exemplar/Case Studies	Use data set of your choice from Open Data Portal (https://data.gov.in/) and apply data preprocessing methods	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Data Aggregation and Analysis	06 Hours
Data Aggregation and Group operations : Group by Mechanics, Data aggregation, General split-apply-combine, Pivot tables and cross tabulation 67 Time Series Data Analysis : Date and Time Data Types and Tools, Time series Basics, date Ranges, Frequencies and Shifting, Time Zone Handling, Periods and Periods Arithmetic, Resampling and Frequency conversion, Moving Window Functions.		
#Exemplar/Case Studies	Study and analyse Weather records/economic indicator/ patient health evolution metrics	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Data Analysis of Visualization and Modelling	06 Hours
Reconstruction, Visualization and Analysis of Medical Images Introduction: - PET Images, Ultrasound Images, Magnetic Resonance Images, Conclusion and Discussion, Case Study: ER/Studio, Erwin data modeler, DbSchema Pro, Archi, SQL Database Modeler, LucidChart, Pgmodeler		
#Exemplar/Case Studies	Creating logical data model for 1 utility company to implement data modeler	
*Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		

Text Books:

1. Chun-houh Chen, Wolfgang Härdle, Antony Unwin, "Handbook of Data Visualization", Springer
2. Ben Fry, "Visualizing Data", O'Reilly Media
3. Clous O.Wilke, "Fundamentals of Data Visualization - A Primer on Making Informative and Compelling Figures", O'Reilly Media, Inc.
4. Kieran Healy, "Data Visualization - A Practical Introduction"
5. McKinney W., "Python for Data Analysis: Data Wrangling with Pandas, NumPy and IPython". 2nd edition, O'Reilly Media
6. Gelman, Andrew, and Jennifer Hill, "Data Analysis Using Regression and Multilevel /Hierarchical Models". 1st edition, Cambridge, UK: Cambridge University Press, 2006, ISBN: 9780521867061
7. Gelman, Andrew, John B. Carlin, Hal S. Stern, and Donald B. Rubin, "Bayesian Data Analysis", 2nd edition, New York, NY: Chapman & Hall, 2003, ISBN: 9781584883883

Reference Books:

1. Gelman, Andrew, and Jennifer Hill, "Data Analysis Using Regression and Multilevel/Hierarchical Models", 1st edition, Cambridge, UK: Cambridge University Press, 2006, ISBN: 9780521867061
2. David Dietrich, Barry Hiller, "Data Science and Big Data Analytics", EMC education services, Wiley publication, 2012, ISBN: 0-07-120413-X
3. Trent Hauk, "Scikit-learn Cookbook", Packt Publishing, ISBN: 9781787286382
4. Chirag Shah, "A Hands-On Introduction to Data Science", Cambridge University Press, 2020, ISBN: 978-1-108-47244-9
5. S. C. Gupta, V. K. Kapoor, "Fundamentals of Mathematics Statistics (A Modern Approach)" "Sultan Chand & Sons Educational Publishers, Tenth revised edition, ISBN: 81-7014-791-3
6. Medhi, "Statistical Methods: An Introductory Text", 2nd Edition, New Age International Ltd., ISBN:8122419577

e-Resources:

1. An Introduction to Statistical Learning by Gareth James
<https://www.ime.unicamp.br/~dias/Intoduction%20to%20Statistical%20Learning.pdf>
2. Python Data Science Handbook by Jake VanderPlas
<https://tanhiamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf>
3. Elements of Statistical Learning: data mining, inference, and prediction, 2nd Edition.
(su.domains)

MOOC Courses:

1. <https://www.youtube.com/watch?v=WSNqcYqByFk>
2. <https://www.youtube.com/watch?v=eFBYJkA3ti4>
3. Computer Science and Engineering - NOC:Data Science for Engineers
4. Computer Science and Engineering - NOC:Python for Data Science
5. Introduction to Data Analytics: <https://nptel.ac.in/courses/110106072>

The CO-PO Mapping Matrix

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

CO3	3	3	1	2	2	2	-	-	-	-	-	-	2
CO4	2	2	2	2	3	2	-	-	-	-	-	-	2
CO5	1	3	2	3	2	-	-	-	-	-	-	-	2
CO6	-	2	2	2	3	-	-	-	-	-	-	-	2

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective III 417523(A): Quantum Artificial Intelligence

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
---	----------------------------	---

Prerequisites Courses: Artificial Intelligence (310253)

Companion Course: Computer Laboratory II (417526)

Course Objectives:

- To get acquainted with the principles of quantum computing and the usage of Linear algebra in Quantum Computing
- To understand the Architecture of Quantum computing and solve examples of Quantum Fourier Transforms
- To understand the concepts of basic and advanced Quantum Algorithms and apply them to various problems.
- To study quantum machine learning and apply these to develop hybrid solutions
- To study the Quantum Theory with Fault-Tolerant Quantum techniques
- To understand Problem-Solving using various peculiar search strategies for AI

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Understand quantum requirements and formulate design solutions using quantum circuits.

CO2: Illustrate applicable solutions in one or more application domains using a quantum architecture that integrates ethical, social, and legal concerns

CO3: Apply the Advanced Quantum Algorithms on real time problem

CO4: Analyze the quantum machine learning algorithms and their relevant application

CO5: Analyze quantum information processing & its relevant algorithms

CO6: Evaluate suitable algorithms for AI problems

Course Contents

Unit I	Introduction to Quantum Computation	06 Hours
Overview of Quantum Computation: Single qubit gates, Multiple qubit gates, Measurements in bases Vs computational basis, Quantum circuits, Qubit copying circuit, Example: Bell states & quantum teleportation.		
Basics of Linear Algebra:	Hilbert Spaces, Products and Tensor Products, Matrices, Graphs, and Sums Over Paths, Example.	
#Exemplar/Case Studies	Case study how to create a Quantum Gate from A Unitary Matrix in Qiskit	
*Mapping of Course Outcomes for Unit I	CO1, CO2	

Unit II	Quantum Architecture	06 Hours
The Framework of Quantum Mechanics: The State of a Quantum System, Time-Evolution of a Closed System, Composite Systems, Mixed States and General Quantum Operations, Universal Sets of Quantum Gates, Quantum measurement and quantum entanglement		
The quantum Fourier transform and its Applications-	The quantum Fourier transform, Phase estimation, order-finding and factoring, General applications of the quantum Fourier transform- Period-finding, Discrete logarithms, The hidden subgroup problem	

#Exemplar/Case Studies	FPGA-based quantum circuit emulation: A case study on Quantum Fourier transform	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Quantum Algorithms	06 Hours
Probabilistic Versus Quantum Algorithms, Phase Kick-Back, The Deutsch Algorithm, The Deutsch–Jozsa Algorithm, Simon's Algorithm, Shor's Algorithm, Factoring Integers, Grover's Algorithm		
#Exemplar/Case Studies	Case study of variational quantum algorithms	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Quantum Machine Learning	06 Hours
Quantum Enhanced Machine Learning: Quantum Algorithms for Linear Algebra, Regression, Clustering, Nearest Neighbour Search, Classification. Quantum Boosting, Quantum Support Vector Machines, Quantum Neural Networks, Variational Quantum Algorithms.		
#Exemplar/Case Studies	Performance comparison of the classical SVM and the QSVM	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Quantum Information Processing	06 Hours
Classical Error Correction: The Error Model Encoding, Error Recovery, The Classical Three-Bit Code, Fault Tolerance.		
Quantum Information: Quantum Teleportation, Quantum Dense Coding, Quantum Key Distribution, Noise and error models in quantum systems, Quantum cryptography and secure communication.		
#Exemplar/Case Studies	Noisy Intermediate Scale Quantum (NISQ)	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Quantum Problem Solving & AI applications	06 Hours
Quantum Problem Solving: Heuristic Search, Quantum Tree Search, Quantum Production System, Tarrataca's Quantum Production System		
Quantum AI Application: Introduction to PennyLane: a cross-platform Python library, Quantum Neural Computation, Quantum Walk – Random insect, Walk on graph, Case studies on Quantum-centric supercomputing: The next wave of computing, Quantum computing for data sciences		
#Exemplar/Case Studies	The Magic-Square Game	
*Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		

Text Books:

1. Nielsen, M. & Chuang I., "Quantum Computation and Quantum Information", 2002
2. Lipton and Reagan, "Quantum Algorithms via Linear Algebra: A Primer"
3. Kaye, LaFlamme and Mosca's, "Introduction to Quantum Computing"
4. Biamonte, J. et al., "Quantum Machine Learning", Nature, 2017
5. Andreas Wichert, "Principles Of Quantum Artificial Intelligence"

Reference Books:

1. Rieffel, E. G. & Polak W. H., "Quantum computing: A gentle introduction", MIT Press, 2011
2. Farhi, E., Goldstone, J. & Gutmann, S., "A quantum approximate optimization algorithm", arXiv preprint arXiv:1411.4028, 2014
3. Kuttler, "Elementary Linear Algebra", 2012
4. Kepner and Gilbert, "Graph Algorithms in the Language of Linear Algebra", 2011
5. Russell, S. & Norvig, P., "Artificial Intelligence: A modern approach", 4th edition, Pearson Education, 2021

e-Resources:

1. <http://mmrc.amss.cas.cn/tlb/201702/W020170224608149940643.pdf>
2. <https://arxiv.org/pdf/1611.09347.pdf>
3. <http://mmrc.amss.cas.cn/tlb/201702/W020170224608150244118.pdf>
4. https://www.researchgate.net/publication/282378154_FPGA-based_quantum_circuit_emulation
5. Microsoft Quantum Development Kit: <https://www.microsoft.com/enus/quantum/development-kit>
Forest
6. Learn quantum programming: <https://pennylane.ai/qml/>
7. Quantum machine learning: <https://qiskit.org/learn/course/machine-learning-course/>
8. Center for Excellence in Quantum Technology: <https://research.ibm.com/blog/next-wave-quantum-centric-supercomputing>

MOOC Courses:

1. <https://nptel.ac.in/courses/106106232>
2. <https://www.coursera.org/learn/introduction-to-quantum-information>
3. <https://www.udemy.com/topic/quantum-computing/>
4. Linear algebra video lectures by Gilbert Strang which are maintained at MITOPENCOURSEWARE: <http://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective III 417523(B): Industrial Internet of Things

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
---	----------------------------	---

Prerequisites Courses: Internet of Things (217529), Cloud Computing (310254(C)), Cyber Security (317530)

Companion Course: Computer Laboratory II (417526)

Course Objectives:

- To understand the concepts of Industrial IOT Systems and its relevance in industrial applications
- To discuss and study the implementation system of IIOT
- To identify IIOT components required for IIOT architecture
- To analyze the cloud computing in context of IIOT
- To scrutinize security challenges and solutions in IIOT system
- Use of IIOT in various applications and provide an understanding of use cases of IIOT beneficial for society

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Understand the basic knowledge of Industrial IOT, its challenges, benefits and significance in industrial applications

CO2: Illustrate the use of sensors, actuators and communication protocols used in implementation of IIOT

CO3: Elaborate the IIOT components required for IIOT architecture

CO4: Analyze the role of cloud computing in IIOT including data storage, processing and data analytics and Digital Twin

CO5: Recognize the importance of security in IIOT and solutions to mitigate security risks

CO6: Categorize the various IIOT applications and use cases of IIoT implemented in various industries

Course Contents

Unit I	Introduction to Industrial Internet of Things (IIoT)	06 Hours
Introduction to IIOT, History of IIOT, IOT Vs. IIOT, The Various Industrial Revolutions (Brief Conceptual Overview), Role of Industrial Internet of Things (IIoT) in Industry, Role of IIOT in Manufacturing Processes, IIOT Requirements and Design Considerations. Use of IIOT in plant maintenance practices, Key opportunities, Challenges and Benefits in implementing IIOT, Applications of IIOT [enlist].		
#Exemplar/Case Studies	The Internet of Things (IoT) is penetrating almost all sectors of the global economy, addressing a wide range of opportunities	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	IIoT System Protocols	06 Hours

Sensors and Actuators used for Industrial Processes, Roles of sensors and actuators in IIOT, IIOT Sensor networks, Process automation and Data Acquisitions on IIoT Platform,

Wireless Communication Technologies: ZigBee and ZigBee IP, Z-Wave, Wi-Fi Backscatter, NFC, 6LoWPAN, RPL [Only characteristic features are expected].

IIoT Low Power WAN Technologies: SigFox, nWave, Dash7, Low Power Wi-Fi, LTE Category-M, Ingenu RPMA [Only technical specifications are expected].

#Exemplar/Case Studies	Building an Industrial IoT Infrastructure with open Source Software for Smart Energy
-------------------------------	--

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

Unit III IIoT Architecture

06 Hours

Overview of IIOT components including Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN.

Architecture of Industrial IoT: Business Model and Reference Architecture of IIOT, Industrial Internet Architecture Framework (IIAF).

Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking

#Exemplar/Case Studies	Airbus uses Bosch's IIoT platform to build a smart factory
-------------------------------	--

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

Unit IV Cloud and Data Analytics for IIoT

06 Hours

IIoT cloud platforms: Overview of Cloud of Things (COT) cloud platforms, Predix, PTC Thing Worx, Microsoft Azure, cloud services, Business Models: SaaS, PaaS, IaaS.

Data Analytics for IIOT: Role of Data Analytics in IIoT & Data visualization Techniques.

Digital Twin for IIOT: Introduction to Digital Twin, Need for Digital Twin, Elements of Digital Twin, Digital Twin Process Design and Information Requirements.

#Exemplar/Case Studies	Building a Hybrid Edge Cloud IIoT Platform
-------------------------------	--

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

Unit V IIoT Security Challenges and Solutions

06 Hours

Introduction- Importance of Security for Industrial IOT, Conventional web technology and relationship with IIoT, Vulnerabilities of IIoT, Privacy, Security requirements.

Components of IIOT Security- Threat analysis, identity establishment, access control, message integrity, non-repudiation and availability. Network security techniques, Management aspects of cyber security.

#Exemplar/Case Studies	An Edge Decentralized Security Architecture for Industrial IoT Applications
-------------------------------	---

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

Unit VI Applications, Use cases and Industry Revolution

06 Hours

Application and Use Cases: - Smart Robotics, Smart Metering, Smart Irrigation, Smart Factory, Healthcare Service Industry, Smart Office, Smart Logistics, Cyber Manufacturing Systems.

Industrial Revolutions: - **Industry 4.0**-Introduction, Definition, Why Industry 4.0 and Why Now? Characteristics, Design Principles, Advantages and applications of Industry 4.0, **Introduction to Industry 5.0 (Society 5.0)**.

#Exemplar/Case Studies	Case Study: Robotics Integrator Discovers Binder Jet 3D Printing for Automotive End-of-Arm Tooling
*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2017
2. S. Misra, C. Roy, and A. Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", CRC Press, 2020
3. Veneri, Giacomo, and Antonio Capasso, "Hands-on Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0", 1st edition, Packt Publishing Ltd., 2018

Reference Books:

1. Ulrich Sendler München, Germany, "The Internet of Things Ulrich Sendler Editor Industrie 4.0 Unleashed", Springer Viewg
2. R. Anandan, Suseendran Gopalakrishnan, Souvik Pal, Noor Zaman, "Industrial Internet of Things (IIoT): Intelligent Analytics for Predictive Maintenance", Wiley publication.

e-Resources:

1. How Protocol Conversion Addresses IIoT Challenges: White Paper ByRed Lion
2. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SECA4005.pdf
3. <https://www.ge.com/digital/applications/digital-twin>
4. <https://www2.deloitte.com/us/en/insights/focus/industry-4-0/digital-twin-technology-smart-factory.html>

MOOC Courses:

1. Introduction to Industry 4.0 and Industrial Internet of Things: https://onlinecourses.nptel.ac.in/noc20_cs69/preview
2. Developing Industrial Internet of Things Specialization: <https://www.coursera.org/specializations/developing-industrial-iot#courses>
3. Industrial Internet of Things (IIoT): <https://www.coursera.org/learn/industrial-internet-of-things>
4. Internet of Things: Sensing and Actuation From Devices: <https://www.coursera.org/learn/internet-of-things-sensing-actuation>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective III 417523(C): Enterprise Architecture and Components

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
--	----------------------------	---

Prerequisites Courses: Software Engineering (210253), Database Management System (310241)

Companion Course: Computer Laboratory II (417526)

Course Objectives:

- To understand the concept of the enterprise information architecture
- To understand different Enterprise architecture frameworks
- To develop skills in designing and implementing enterprise architectures
- To discuss component model and Discuss the operational characteristics of the EIA Reference Architecture
- To describe the strategy for Metadata Management within information-centric use case scenarios
- To Analyze tools of Enterprise Architecture in Modern Organizations

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Understand the fundamental principles and concepts of enterprise architecture

CO2: Describe how the domains can be managed within the enterprise though a coherent Information Governance framework

CO3: Implement EA Process in Enterprise Architecture Design

CO4: Interpret the component and operational model characteristics of the EA Reference Architecture

CO5: Analyze strategy for Metadata Management using use case scenarios

CO6: Choose appropriate tool for Enterprise Architecture in Modern Organization

Course Contents

Unit I	Introduction to Enterprise Architecture	06 Hours
An Introduction to Enterprise Architecture, importance of enterprise architecture, Benefits of enterprise architecture, Challenges for enterprise level designing, Anti Patterns, EA Principles and Methodologies the EA Core Diagram. Lean and Agile EA: Applying Lean and Agile Methods to EA, Lean and Agile Principles: Involve All Stakeholders by Interlocking Architecture Scrums, Practice Iterative Architecture Through EA Kanban		
#Exemplar/Case Studies	Enterprise Architecture is Infosys Limited	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Architecture Frameworks	06 Hours
Enterprise architecture frameworks and methodologies, EA Frameworks and Tools; Business Architecture, Application Architecture, Data Architecture, Technology Architecture. Architecture Languages: IDEF, BPMN, Test bed, ARIS, Unified Modeling Language, Architecture Description Languages, Suitability for Enterprise Architecture, Service-Oriented Architecture, Service-Oriented Technologies, Relevance and Benefits for Enterprise Architecture.		

#Exemplar/Case Studies	Architecture Frameworks is Tata Consultancy Services (TCS)	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III Enterprise Architecture Design and Implementation	06 Hours	
Architecture Development Process Overview - plan the EA process, characterize the baseline architecture, Develop the target architecture vision, Architecture design principles, Architecture implementation best practices, Architecture governance		
#Exemplar/Case Studies	An enterprise architecture approach to forest management support systems design	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV Enterprise Information Architecture: Component and Operational Model	06 Hours	
Enterprise information architecture: Overview, The component model, component relationship diagram, component description, component interaction diagrams- a deployment scenario. Terminology and definitions, Context of operational model design techniques, service qualities, Standards used for operational model relationship diagram framework of operational patterns		
#Exemplar/Case Studies	Description of Integrated Components for Validation - A Case Study of Student Internship Programme	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V Metadata and Master Data Management	06 Hours	
Metadata Management Best Practices - Strategies for effective metadata management, Master Data Management Implementation- Steps and considerations for implementing a master data management system- Master data integration Metadata and Master Data Interoperability- Interoperability standards and protocols for metadata and master data exchange- Cross-domain metadata and master data integration- Metadata and master data mapping and transformation techniques qualities.		
#Exemplar/Case Studies	Example of Real-World Metadata and Master Data Management Implementation: Company: Acme Manufacturing	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI Role of Enterprise Architecture in Modern Organizations	06 Hours	
Enterprise architecture and digital transformation, Enterprise architecture and IT strategy, Enterprise Architecture Governance, Enterprise Architecture and Business Process Management, Enterprise Architecture Tools and Technologies, Tools and Resources used for enterprise designing, Enterprise Architecture and Organizational Change		
#Exemplar/Case Studies	Procter & Gamble (P&G). P&G is a multinational consumer goods company headquartered in Cincinnati, Ohio, USA	
*Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		

Text Books:

1. Marc Lankhorst et. al., "Enterprise Architecture at Work: Modeling, Communication and Analysis"
2. Neal McWhorter , "Enterprise Architecture The Art and Practice of Business"
3. David Marco, "Metadata Management for Information Control and Business Success", Wiley, 2013

Reference Books:

1. Stefan Bente, Uwe Bombosch, Shailendra Langade, "Collaborative Enterprise Architecture"
2. Lankhorst Marc, "Enterprise Architecture at Work"
3. Neal McWhorter, "Enterprise Architecture for Digital Business"
4. Scott A. Bernard, "An Introduction to Enterprise Architecture", 3rd edition

e-Resources:

1. <https://www.coursera.org/specializations/ibm-ai-workflow>
2. Enterprise Architecture (Coursera)

MOOC Courses:

1. Prof. Jenamani, IIT Kharagpur, E-business, <https://nptel.ac.in/courses/110/105/110105083/>
2. The Practice of Enterprise Architecture (Part I): <https://www.udemy.com/course/the-practice-of-enterprise-architecture-part-i/>
3. Enterprise Architecture: <https://www.classcentral.com/course/enterprise-architecture-17941>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective III 417523(D): Bioinformatics

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
--	----------------------------	---

Prerequisites Courses: Statistics (217528), Artificial intelligence (310253), Data Science (317529)

Companion Course: Computer Laboratory II (417526)

Course Objectives:

- To study fundamental concepts of bioinformatics
- To study knowledge from basic to advanced level
- To refer appropriate, suitable datasets
- To study appropriate Bioinformatics tools
- To visualize and analyse recent research

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Become aware of concept of bioinformatics

CO2: Apply Knowledge from basic to advanced level in bioinformatics

CO3: Learn major topics of Bioinformatics

CO4: Demonstrate different biological suitable datasets

CO5: Demonstrate appropriate Bioinformatics tools

CO6: Connect and integrate the knowledge obtained for applications related to Bioinformatics, their tools and database

Course Contents

Unit I	Introduction to Bioinformatics and Molecular Biology	06 Hours
Introduction to bioinformatics and its importance. Overview of molecular biology and biotechnology. Understanding biological molecules and cellular processes. DNA, RNA, protein and their functions. Genome wide Association Studies.		
#Exemplar/Case Studies	Genomics and Bioconductor	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Computational Genomics and Transcriptomics	06 Hours
DNA sequence analysis. Intron, Exon, Microarray, RNAseq. Genome annotation and gene prediction. RNA sequencing and analysis. Differential gene expression analysis. NCBI datasets, repositories.		
#Exemplar/Case Studies	Genomic Data Visualization	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Structural Bioinformatics and Drug Discovery	06 Hours

Protein structure prediction. Homology modeling and threading. Protein-ligand interactions and molecular docking. Computer-aided drug design. Data Science for Medical Image analysis.

#Exemplar/Case Studies	Structural Bioinformatics, Cross-cell line Transcriptomic Signature Predictions	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Systems Biology and Network Analysis	06 Hours
Overview of systems biology. Regulatory networks. Metabolic networks. Network analysis and visualization tools.		
#Exemplar/Case Studies	AstraZeneca	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Data Mining and Machine Learning in Bioinformatics	06 Hours
Introduction to data mining and machine learning. Clustering and classification. Feature selection and dimensionality reduction. Deep learning in bioinformatics. Machine Learning, Deep Learning, Convolution Neural Network Application for Gene Networks		
#Exemplar/Case Studies	DeepChem and Facial Emotion Recognition	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Applications of Bioinformatics	06 Hours
Personalized medicine and pharmacogenomics. Disease diagnosis and treatment. Agricultural and environmental biotechnology. Current research and future directions. Implementation use cases on recent research through Researchgate, GitHub.		
#Exemplar/Case Studies	Awesome Bioinformatics	
*Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		
Text Books:		
<ol style="list-style-type: none"> 1. S.C. Rastogi & others, “Bioinformatics- Concepts, Skills, and Applications”, 2nd edition, CBS Publishing, 2016, ISBN: 9788123914824 2. Cynthia Gibas and Per Jambeck, “Developing Bioinformatics Computer Skills” O'Reilly press, Shorff Publishers and Distributors Pvt. Ltd., 3. Mario Cannataro, Pietro Hiram Guzzi, et.al., “Artificial Intelligence in Bioinformatics”, Elsevier Science 4. Bourne PE, Weissig H., “Structural Bioinformatics” (Methods of Biochemical Analysis, V. 44). Wiley-Liss, 2003 		

Reference Books:

1. Basant K. Tiwary, “Bioinformatics and Computational Biology : A Primer for Biologists”, Springer Nature, 2021
2. Zoe’Lacroix and critchlow, “Bioinformatics: Managing scientific data”, Morgan Kaufmann, 2004
3. Campbell AM and Heyer LJm, “Discovering Genomics, Proteomics and Bioinformatics”, Pearson Education
4. S.C., Rastogi, Parag, Mendiratta, Namita, “Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery”, 5th edition, PHI Learning, 2022

e-Resources:

1. <http://www.bioinformatics.org/>
2. https://ocw.mit.edu/ans7870/6/6.047/f15/MIT6_047F15_Compiled.pdf

MOOC Courses:

1. <https://archive.nptel.ac.in/courses/102/106/102106065/>
2. <https://www.udemy.com/course/genetics-and-next-generation-sequencing-for-bioinformatics/>
3. <https://www.coursera.org/specializations/bioinformatics>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective IV 417524(A): GPU Programming and Architecture

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
---	----------------------------	---

Prerequisites Courses: Computer Graphics (210244)

Companion Course: Computer Laboratory II (417526)

Course Objectives:

- To understand Graphics Processing Unit (GPU) architecture
- To understand the basics of CUDA programming
- To write programs for massively parallel processors
- To understand the issues in mapping algorithms for GPUs
- To introduce different GPU programming models
- To optimize and evaluate the performance of modern GPUs

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Describe GPU architecture

CO2: Apply CUDA architecture for parallel programming

CO3: Analyze programming issues in CUDA programming

CO4: Acquire proficiency in programming GPUs using OpenCL

CO5: Identify efficient parallel programming patterns to solve problems

CO6: Apply programming skills that make efficient use of the GPU processing power

Course Contents

Unit I	Introduction to GPU Architecture	06 Hours
Evolution of GPU architectures – Understanding Parallelism with GPU –Typical GPU Architecture – CUDA Hardware Overview – Threads, Blocks, Grids, Warps, Scheduling, Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory.		
#Exemplar/Case Studies	Review of Traditional Computer Architecture	
*Mapping of Course	CO1	
Outcomes for Unit I		
Unit II	CUDA Programming	06 Hours
Benefits of using GPU, CUDA-A General-Purpose Parallel Computing Platform and Programming Model, A scalable Programming Model, Programming Model - Kernels, Thread Hierarchy, Memory Hierarchy, Heterogeneous Programming, Asynchronous SIMT Programming Model, Compute Capability, Using CUDA – Multi CPU – Multi GPU Solutions, Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions		
#Exemplar/Case Studies	GPU applications using SYCL and CUDA on NVIDIA	
*Mapping of Course	CO2	
Outcomes for Unit II		

Unit III CUDA Programming Issues		06 Hours
Common Problems: CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors. Compilation with NVCC-Compilation Workflow, Binary Compatibility, PTX Compatibility, Application Compatibility, C++Compatibility, 64-bit Compatibility, CUDA Runtime		
#Exemplar/Case Studies	Image feature extraction algorithm based on CUDA architecture	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV Introduction to OpenCL Programming		06 Hours
The basic ideas of OpenCL programs, what kind of parallel programming model is OpenCL? Common tasks of OpenCL host programs, alternatives to OpenCL for GPU programming? OpenCL Standard – Kernels – Host Device Interaction – Execution Environment – Memory Model– Basic OpenCL Examples		
#Exemplar/Case Studies	Exploiting Task Parallelism with OpenCL	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V Algorithms on GPU		06 Hours
Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix – Matrix Multiplication – Programming Heterogeneous Cluster, Performance- Synchronization, Dynamic-parallelism-enabled Kernel Overhead, Implementation, Restrictions, and Limitations- Runtime-Memory Footprint, Nesting and Synchronization Depth, Pending Kernel Launches, Configuration Options, Memory Allocation and Lifetime.		
#Exemplar/Case Studies	Accelerating genetic algorithms with GPU computing: A selective overview	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI OpenCL and Application Design		06 Hours
OpenCL Platform Model, OpenCL Memory Model, Application Specific Processors (ASP), Transport Triggered Architecture (TTA), Practical Issues in compiling OCL Standalone Execution of OpenCL Applications, OpenCL for Heterogeneous Computing, Application Design: Efficient Neural Network Training/Inferencing		
#Exemplar/Case Studies	GPU-Accelerated Cone-Beam CT	
*Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		

Text Books:

- Shane Cook, "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing)", 1st edition, Morgan Kaufmann, 2012
- David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, "Heterogeneous computing with OpenCL", 3rd edition, Morgan Kauffman, 2015
- Benedict Gaster, LeeHowes, David R. Kaeli, "Heterogeneous Computing with OpenCL", 2012

Reference Books:

- Nicholas Wilt, "CUDA Handbook: A Comprehensive Guide to GPU Programming", Addison –Wesley, 2013
- Jason Sanders, Edward Kandrot, "CUDA by Example: An Introduction to General Purpose GPU Programming", Addison – Wesley, 2010
- David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors, A Hands-on Approach", 3rd edition, Morgan Kaufmann, 2016
- CUDA C++ Programming Guide
<https://docs.nvidia.com/cuda/cuda-c-programming-guide/index.html#compilation-with-nvcc>
- CUDA Toolkit
<https://developer.nvidia.com/cuda-zone>
- OpenCL <http://www.openCL.org>

e-Resources:

- https://edoras.sdsu.edu/~mthomas/docs/cuda/cuda_by_example.book.pdf
- <https://www.cs.utexas.edu/~rossbach/cs380p/papers/cuda-programming.pdf>
- <https://www.syncfusion.com/succinctly-free-ebooks/confirmation/cuda>
- <https://ptgmedia.pearsoncmg.com/images/9780321749642/samplepages/0321749642.pdf>

MOOC Courses:

- https://onlinecourses.nptel.ac.in/noc20_cs41/preview

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective IV 417524(B): Information Retrieval

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
---	----------------------------	---

Prerequisites Courses: Data Structures and Algorithms (210252), Database management systems(310241)

Companion Course: Computer Laboratory II (417526)

Course Objectives:

- To understand the basics of Information Retrieval
- To understand the concepts of Indexing & Query Processing for Information Retrieval
- To provide comprehensive details about various Evaluation methods
- To understand the different methods of Text Classification and Clustering
- To understand various search engine system operations and web structures
- To understand various applications of Information Retrieval

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Understand the concept of Information Retrieval

CO2: Use an indexing approach for retrieval of documents

CO3: Evaluate and analyze the retrieved information

CO4: Apply appropriate method of Text Classification and Clustering

CO5: Design and implement innovative features in search engines

CO6: Analyze different real-life application of Information Retrieval

Course Contents

Unit I	Introduction	06 Hours
Introduction to information retrieval, Major challenges in IR, Features of an IR system, components of an IR model, IR system block diagram, Boolean retrieval, Information versus Data Retrieval, Text categorization, IR processes and fields, Vector Model, Probabilistic Model and Latent Semantic Indexing Model.		
#Exemplar/Case Studies	Visualization and Information Retrieval Techniques for Network Intrusion Detection	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Dictionaries and Query Processing	06 Hours
Components of Index, Index Life Cycle, Static Inverted Index, Dictionaries-Types (Sort Based, Hash Based, Interleaving & Posting Lists), Index Construction (In memory, Sort Based, Merge Based, Disk Based Index Construction), Dynamic Indexing, Query Processing for Ranked Retrieval, Document at a Time Query Processing, Term at a Time Query Processing, Pre-computing Score Contributions, Impact Ordering, Query Optimization.		
#Exemplar/Case Studies	Matching of the searched statement with the database which is already stored	

*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Probabilistic Retrieval and Language Modelling related methods	06 Hours
Probabilistic Retrieval: Review of Basic Probability Theory; The Probability Ranking Principle: The 1/0 loss case, the PRP with retrieval costs; The Binary Independence Model; Term Frequency; An appraisal and some extensions: An appraisal of probabilistic models, tree-structured dependencies between terms, Okapi BM25: a non-binary model, Bayesian network approaches to IR, Relevance Feedback, Field Weights:BM25F. Language models for information retrieval: generating queries from documents; Language models: finite automata and language models; types of language models; multinomial distributions over words; Ranking with Language Models; Divergence from Randomness, Passage Retrieval, and Ranking.		
#Exemplar/Case Studies A Comparative Study of Probabilistic and Language Models for Information Retrieval		
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Text classification & Text clustering	06 Hours
Text Classification: Introduction to Text Classification, Naïves Bayes Model, K Nearest neighbor, spam filtering, Support Vector Machine Classifier, Vector Space classification using hyperplanes, kernel function. Text Clustering: Clustering vs Classification, partitioning methods. Clustering Algorithms: k-means clustering, Agglomerative hierarchical clustering, Expectation Maximization, Mixture of Gaussians Model		
#Exemplar/Case Studies	Case Study: Improving Document Organization and Retrieval in a Digital Library	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Web Retrieval and Web Crawling	06 Hours
Parallel information retrieval: Parallel query processing, Mapreduce Web Retrieval: Search Engine Architectures, Cluster based Architecture, Distributed Architectures, Search Engine Ranking. Link based Ranking, Page Ranking Algorithm, Simple Ranking Functions and Evaluations. Web Crawler: Web Crawler structure, Web crawler libraries, Python Scrapy, Beautiful Soup, Applications		
#Exemplar/Case Studies	Study of Google Map/ Geogusser information retrieval	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	IR applications	06 Hours
Multimedia Information Retrieval: Spoken Language Audio Retrieval, Non-Speech Audio Retrieval, Graph Retrieval, Imagery Retrieval, Video Retrieval Recommender System: Collaborative Filtering, Content Based Recommendation, Knowledge Based Recommendation Information Extraction and Integration: Extracting Data from Text. Semantic Web, Collecting and Integrating Specialized Information on the web.		
#Exemplar/Case Studies	Demonstrate Collaborative filtering using any datasets to recommend items to users	

*Mapping of Course Outcomes for Unit VI	CO6
	Learning Resources

Text Books:

1. C. Manning, P. Raghavan, and H. Schütze, "Introduction to Information Retrieval", Cambridge University Press, 2008, ISBN: 9780521865715
2. S. Buttcher, C. Clarke, and G. Cormack, "Information Retrieval: Implementing and Evaluating Search Engines" MIT Press, 2010, ISBN: 0-408-70929-4
3. Bruce Croft, Donald Metzler and Trevor Strohman, "Search Engines: Information Retrieval in Practice", 1st edition, Addison Wesley, 2009, ISBN: 9780135756324
4. Jannach D., Zanker M. and FelFering A., "Recommender Systems: An Introduction", 1st edition, Cambridge University Press

Reference Books:

1. Manouselis N., Drachsler H., Verbert K., Duval E., "Recommender Systems For Learning", 1st edition, Springer, 2013
2. G. Kowalski, M.T. Maybury, "Information storage and Retrieval System", Springer, 2005
3. W.B. Croft, J. Lafferty, "Language Modeling for Information Retrieval", Springer, 2003

e-Resources:

1. Information Retrieval- <http://www.informationretrieval.org>

MOOC Courses:

1. <https://www.youtube.com/watch?v=fFxpSmyICwI>
2. <https://www.youtube.com/watch?v=X5GvBh4qY0s>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective IV 417524(C): UI/UX Design

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
--	---------------------	---

Prerequisites Courses: Design Thinking (

Companion Course: Computer Laboratory II (417526)

Course Objectives:

- To learn the factors that determine how people use technology
- To study the usable software-enabled user-interfaces
- To achieve efficient, effective, and safe interaction
- To Explore various models and factors that affect response time
- To explore the challenges associated with information visualization and its societal and individual impacts.
- To learn Usability evaluation methods

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Understand the principles of User Interface

CO2: Describe user experience fundamentals

CO3: Explore strategies for managing design projects

CO4: Recognize the quality of service and data visualization

CO5: Explore the challenges associated with information visualization

CO6: Test the usability of a design through usability evaluations

Course Contents

Unit I	Unit Introduction and Overview of UI	06 Hours
The Human –I/P, O/P channels, Human Memory, thinking, emotion, individual difference (diversity), human psychology.		
Introduction to User Interface Design (UI)	-The Relationship Between UI and UX , Roles in UI/UX, A Brief historical Overview of Interface Design, Interface Conventions, Approaches to Screen Based UI, Template vs Content, Formal Elements of Interface Design, Active Elements of Interface Design, Composing the Elements of Interface Design, UI Design Process, Visual Communication design component in Interface Design , Application of UI design	
Introduction to Design Technologies and Tools	Sketch ,Wireframe ,Invision, Axure, Figma, Flutter, Mockups	
#Exemplar/Case Studies	Redesigning a Mobile E-commerce App	
*Mapping of Course	CO1	
Outcomes for Unit I		
Unit II	Unit User Experience	06 Hours

UX Basics- Foundation of UX design, Good and poor design, Understanding Your Users, Designing the Experience Elements of user Experience, Visual Design Principles, Functional Layout, Interaction design, Introduction to the Interface, Navigation Design, User Testing, Developing and Releasing Your Design

User experience and user interaction-Usability of interactive systems, goals and measures, Universal Usability, Characteristics of graphical and web user interfaces, guidelines, principles and theories of good design, User Experience- Concept of UX, Trends in UX, 6 Stages used to UX design , Applications of UX design

#Exemplar/Case Studies	Redesigning a Health and Fitness Mobile App
*Mapping of Course Outcomes for Unit II	CO2

Unit III	Unit Design Process	06 Hours
Managing design processes, organizational design to support usability, pillars of design, development methodologies, Human considerations in Design, Usability- principles to support usability, assessment in the design process, Usability problems, practical measures of usability, objective measures of usability, golden rules of interface design, Evaluating Interface Design – Introduction, Expert reviews, Usability testing, Acceptance tests, Legal issues		

#Exemplar/Case Studies	Redesign of a mobile banking application
*Mapping of Course Outcomes for Unit III	CO3

Unit IV	Unit Interaction Styles	06 Hours
Direct manipulation and virtual environment, Develop system menus and navigation schemes- Structure of menus, Function of menus, content of menus, phrasing the menu, navigating menus, kinds of graphical menus, form fill-in and dialog boxes, command- organization , functionality, strategies and structure, naming and abbreviations, interaction devices, collaboration and social media participation		

#Exemplar/Case Studies	
*Mapping of Course Outcomes for Unit IV	CO4

Unit V	Unit Implementation support and Screen Based Controls	06 Hours
---------------	--	-----------------

Implementation support: Support, training and learning, requirement of user support, element of windowing systems,Individual window design, multiple window design, command organization strategies command menus, natural languages in computer

Screen Based Controls: Selection control-Radio buttons, check boxes, list boxes, Read-only controls- text boxes, Operablecontrols - buttons, slider, tab, scroll bar, clear text and messages, text for web pages, Graphics, icons and images, Presentation controls-Static text fields, Group boxes, column headings, tool tips,progress indicators

#Exemplar/Case Studies	
*Mapping of Course Outcomes for Unit V	CO5

Unit VI	Unit Usability Evaluation and Design Issues	06 Hours
----------------	--	-----------------

Quality of service- Models of response time impacts, user productivity, variability in response time, Balancing function and fashion- Error messages, display design, web page design, window design, color, Information visualization – data type by task taxonomy, challenges for information visualization, societal and individual impact of user interface

Usability Evaluation Methods :

Usability Testing ,Heuristic evaluations , Cognitive walkthrough, Surveys and Questionnaires
Eye Tracking, A/B Testing, Remote Usability Testing, Think-Aloud Protocol, Comparative Usability Evaluation

#Exemplar/Case Studies	
*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. Creative Tim, "Fundamentals of Creating a Great UI/UX", 1st edition
2. Jon Yablonski, "Laws of UX: Using Psychology to Design Better Products & Services", O'REILLY Publication
3. Jenifer Tidwell, Charles Brewer, Aynne Valencia, "Designing Interfaces: Patterns for Effective Interaction Design", O'REILLY Publication

Reference Books:

1. Shneiderman, Plaisant, Cohen, Jacobs, "Designing the User Interface-Strategies for Effective Human Computer Interaction", 5th edition, PEARSON Publication
2. Wilbert O. Galitz, "The Essential Guide to User Interface Design", 2nd edition, WILEY Publication
3. Alan Dix, Janet Finlay, Gregory D. Abowd, Russell Beale, "Human–Computer Interaction, 3rd edition
4. Alan Coopen, "The essentials of interaction"

e-Resources:

1. "The Guide to Wireframing" by UXPin: <https://www.uxpin.com/studio/ebooks/guide-to-wireframing/> - This eBook provides an in-depth guide to wireframing, covering the basics, best practices, and tips for creating effective wireframes.
2. "UX Design for Startups" by Marcin Treder: <https://uxpin.com/studio/ebooks/ux-design-for-startups/> - This eBook focuses on UX design principles and strategies specifically tailored for startups, covering topics like user research, prototyping, and user testing.

MOOC Courses:

1. User Interface Design: https://onlinecourses.nptel.ac.in/noc21_ar05/preview

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective IV 417524(D): Optimization Algorithms

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
--	---------------------	---

Prerequisites Courses: Discrete Mathematics (210241), Data Structures and Algorithms (210252)

Companion Course: Computer Laboratory II (417526)

Course Objectives:

- To understand the need of optimization Algorithms
- To apply the optimization techniques while solving the problems
- To understand the constraints applied and optimization of the algorithm
- To optimize searching strategies
- To understand and use Self Optimizing algorithms

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Identify Optimization Concepts to incorporate in problem solving in effective way

CO2: To formulate given optimization problem mathematically precisely

CO3: To create model using Optimization Techniques, like linear programming, integer programming and dynamic programming

CO4: To select an optimization strategy to tackle complex optimization problems and evaluate the optimization algorithms

CO5: To distinguish strategies of Optimization Algorithms selected

CO6: To construct an Optimization strategy to solve different problems

Course Contents

Unit I	Introduction	06 Hours
Introduction, Fundamentals of Optimization, general structure of the optimization algorithms, types of optimization problems, examples of optimization, formulation of optimization problem, classification of optimization algorithms, traveling salesman and knapsack problem		
#Exemplar/Case Studies	Analyze the traveling salesman problem for optimization	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Classical Optimization	06 Hours
Introduction, Mathematical model of optimization, Optimality conditions, Solution techniques -Penalty function, Linear programming (LP)-Formulation of LP Problem Optimality conditions, Integer Linear Programming, LP duality-Farkas Lemma, Quadratic Programming (QP) -Convex QP problems, Convex Programming, general constraint optimization problem		
#Exemplar/Case Studies	Solve the Multistage Graph Problem with Dynamic Programming	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Constraint Optimization	06 Hours

Introduction Linear Programming-Simplex Method, Revised Simplex Method, Karmarkar's Method, Duality Theorem and Transportation Problem, **Non-linear Programming**-Quadratic and Geometric Programming, Karush–Kuhn–Tucker (KKT) conditions test as necessary condition. **Dynamic Programming**- Continuous vs Discrete dynamic programming, multistage graph problem, traveling salesman and knapsack problem

#Exemplar/Case Studies	Solving linear equations with Genetic Algorithms	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Search Optimization	06 Hours
Introduction, Genetic Algorithms -Initialize population, Fitness Evaluation, Reproduction, Crossover and Mutation, Multimodel test function, Solving linear equations with genetic algorithm, Simulated Annealing(SA) -Annealing and Boltzmann Distribution, Parameters, SA Algorithm, Unconstrained Optimization, Basic Convergence Properties, SA Behavior in Practice and Stochastic Tunneling, Particle Swarm Optimization(PSO) -Introduction, Swarm Behavior, PSO Algorithm, Variants of PSO Algorithm		
#Exemplar/Case Studies	Penalty function implementation in convex computation	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Differential Evolution and Swarm Optimization	06 Hours
Introduction, Differential Evolution -Introduction, Differential Evolution, Variants, Choice of Parameters Convergence Analysis and Implementation. Swarm Optimization -Swarm Intelligence, PSO Algorithm, Accelerated PSO, Convergence Analysis-PSO, Binary PSO, Multiobjective Optimization - Pareto Optimality, Constraint Methods, Weight Methods, Preference Elicitation, Ant colony optimization(ACO)		
#Exemplar/Case Studies	Binary PSO implementation	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Self Tuning Algorithms	06 Hours
Introduction, Algorithm Analysis and Parameter Tuning, Framework for Self-Tuning Algorithms, A Self-Tuning Firefly Algorithm - Firefly Behavior, Standard Firefly Algorithm, Variations of Light Intensity and Attractiveness, Controlling Randomization Variants of the Firefly Algorithm, Firefly Algorithms in Applications, Bat Algorithm - Echolocation of Bats, Bat Algorithms, Binary Bat Algorithms, Convergence Analysis, Applications		
#Exemplar/Case Studies	Implementation of Firefly algorithm to understand the self tuning	
*Mapping of Course Outcomes for Unit VI	CO6	

Learning Resources

Text Books:

1. Andreas Antoniou, Wu-Sheng Lu, “Practical optimization algorithms and engineering applications”, Springer, 2007
2. Vasuki A., “Nature Inspired Optimization Algorithms”, CRC Press, 2020
3. Mykel J. Kochenderfer, Tim A. Wheeler, “Algorithms for Optimization”, MIT Press, 2019

Reference Books:

1. Rajesh Kumar Arora, "Optimization Algorithms and Applications", Chapman & Hall, CRC, 2015
2. A Schrijver, "Theory of Linear and Integer Programming" (Wiley Series in Discrete Mathematics & Optimization)
3. V. Chvatal, "Linear Programming"

MOOC Courses:

1. <https://www.coursera.org/learn/optimization-for-decision-making>
2. <https://www.coursera.org/learn/solving-algorithms-discrete-optimization>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417525: Computer Laboratory I

Teaching Scheme: PR: 04 Hours/Week	Credit 02	Examination Scheme and Marks Term Work (TW): 50 Marks Practical (PR): 25 Marks
---	----------------------------	---

Prerequisite Courses: Data Science (317529), Artificial Neural Network (317531)

Companion Course: Machine Learning (417521), Data Modeling and Visualization (417522)

Course Objectives:

- Apply regression, classification and clustering algorithms for creation of ML models
- Introduce and integrate models in the form of advanced ensembles
- Conceptualized representation of Data objects
- Create associations between different data objects, and the rules
- Organized data description, data semantics, and consistency constraints of data

Course Outcomes:

After completion of the course, learners should be able to-

- CO1:** Implement regression, classification and clustering models
- CO2:** Integrate multiple machine learning algorithms in the form of ensemble learning
- CO3:** Apply reinforcement learning and its algorithms for real world applications
- CO4:** Analyze the characteristics, requirements of data and select an appropriate data model
- CO5:** Apply data analysis and visualization techniques in the field of exploratory data science
- CO6:** Evaluate time series data

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.

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 needs 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, Instructors may also set one assignment or mini-project that is suitable to AI & DS branch beyond the scope of the syllabus.

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

Programming tools recommended: - Open Source Python, Programming tool like Jupyter Notebook, Pycharm, Spyder.

PART-1(Machine Learning): 6 Assignments

PART- II(Data Modeling and Visualization): 6 Assignments

PART-III(Mini Project): Mandatory Assignment

Virtual Laboratory

<https://cse20-iiith.vlabs.ac.in/>

Suggested List of Laboratory Experiments/Assignments

Part I: Machine Learning

	Feature Transformation (Any one)
1	<p>A. To use PCA Algorithm for dimensionality reduction. You have a dataset that includes measurements for different variables on wine (alcohol, ash, magnesium, and so on). Apply PCA algorithm & transform this data so that most variations in the measurements of the variables are captured by a small number of principal components so that it is easier to distinguish between red and white wine by inspecting these principal components. Dataset Link: https://media.geeksforgeeks.org/wp-content/uploads/Wine.csv</p> <p>B. Apply LDA Algorithm on Iris Dataset and classify which species a given flower belongs to. Dataset Link:https://www.kaggle.com/datasets/uciml/iris</p>
2	<p>Regression Analysis:(Any one)</p> <p>A. Predict the price of the Uber ride from a given pickup point to the agreed drop-off location. Perform following tasks:</p> <ol style="list-style-type: none"> 1. Pre-process the dataset. 2. Identify outliers. 3. Check the correlation. 4. Implement linear regression and ridge, Lasso regression models. 5. Evaluate the models and compare their respective scores like R2, RMSE, etc. <p>Dataset link: https://www.kaggle.com/datasets/yasserh/uber-fares-dataset</p> <p>B. Use the diabetes data set from UCI and Pima Indians Diabetes data set for performing the following:</p> <ol style="list-style-type: none"> a. Univariate analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis b. Bivariate analysis: Linear and logistic regression modeling c. Multiple Regression analysis d. Also compare the results of the above analysis for the two data sets <p>Dataset link: https://www.kaggle.com/datasets/uciml/pima-indians-diabetes-database</p>

3	Classification Analysis (Any one) <ul style="list-style-type: none"> A. Implementation of Support Vector Machines (SVM) for classifying images of hand-written digits into their respective numerical classes (0 to 9). B. Implement K-Nearest Neighbours' algorithm on Social network ad dataset. Compute confusion matrix, accuracy, error rate, precision and recall on the given dataset. Dataset link: https://www.kaggle.com/datasets/rakeshrau/social-network-ads
4	Clustering Analysis (Any one) <ul style="list-style-type: none"> A. Implement K-Means clustering on Iris.csv dataset. Determine the number of clusters using the elbow method. Dataset Link: https://www.kaggle.com/datasets/uciml/iris B. Implement K-Mediod Algorithm on a credit card dataset. Determine the number of clusters using the Silhouette Method. Dataset link: https://www.kaggle.com/datasets/arjunbhasin2013/ccdata
5	Ensemble Learning (Any one) <ul style="list-style-type: none"> A. Implement Random Forest Classifier model to predict the safety of the car. Dataset link: https://www.kaggle.com/datasets/elikplim/car-evaluation-data-set B. Use different voting mechanism and Apply AdaBoost (Adaptive Boosting), Gradient Tree Boosting (GBM), XGBoost classification on Iris dataset and compare the performance of three models using different evaluation measures. Dataset Link: https://www.kaggle.com/datasets/uciml/iris
6	Reinforcement Learning (Any one) <ul style="list-style-type: none"> A. Implement Reinforcement Learning using an example of a maze environment that the agent needs to explore. B. Solve the Taxi problem using reinforcement learning where the agent acts as a taxi driver to pick up a passenger at one location and then drop the passenger off at their destination. C. Build a Tic-Tac-Toe game using reinforcement learning in Python by using following tasks <ul style="list-style-type: none"> a. Setting up the environment b. Defining the Tic-Tac-Toe game c. Building the reinforcement learning model d. Training the model e. Testing the model

Part II: Data Modeling and Visualization

7	Data Loading, Storage and File Formats Problem Statement: Analyzing Sales Data from Multiple File Formats Dataset: Sales data in multiple file formats (e.g., CSV, Excel, JSON) Description: The goal is to load and analyze sales data from different file formats, including CSV, Excel, and JSON, and perform data cleaning, transformation, and analysis on the dataset. Tasks to Perform: Obtain sales data files in various formats, such as CSV, Excel, and JSON. <ol style="list-style-type: none"> 1. Load the sales data from each file format into the appropriate data structures or dataframes. 2. Explore the structure and content of the loaded data, identifying any inconsistencies, missing values, or data quality issues. 3. Perform data cleaning operations, such as handling missing values, removing duplicates, or correcting inconsistencies. 4. Convert the data into a unified format, such as a common dataframe or data structure, to enable seamless analysis.
---	--

	<p>5. Perform data transformation tasks, such as merging multiple datasets, splitting columns, or deriving new variables.</p> <p>6. Analyze the sales data by performing descriptive statistics, aggregating data by specific variables, or calculating metrics such as total sales, average order value, or product category distribution.</p> <p>7. Create visualizations, such as bar plots, pie charts, or box plots, to represent the sales data and gain insights into sales trends, customer behavior, or product performance.</p>
8	<p>Interacting with Web APIs</p> <p>Problem Statement: Analyzing Weather Data from OpenWeatherMap API</p> <p>Dataset: Weather data retrieved from OpenWeatherMap API</p> <p>Description: The goal is to interact with the OpenWeatherMap API to retrieve weather data for a specific location and perform data modeling and visualization to analyze weather patterns over time.</p> <p>Tasks to Perform:</p> <ol style="list-style-type: none"> 1. Register and obtain API key from OpenWeatherMap. 2. Interact with the OpenWeatherMap API using the API key to retrieve weather data for a specific location. 3. Extract relevant weather attributes such as temperature, humidity, wind speed, and precipitation from the API response. 4. Clean and preprocess the retrieved data, handling missing values or inconsistent formats. 5. Perform data modeling to analyze weather patterns, such as calculating average temperature, maximum/minimum values, or trends over time. 6. Visualize the weather data using appropriate plots, such as line charts, bar plots, or scatter plots, to represent temperature changes, precipitation levels, or wind speed variations. 7. Apply data aggregation techniques to summarize weather statistics by specific time periods (e.g., daily, monthly, seasonal). 8. Incorporate geographical information, if available, to create maps or geospatial visualizations representing weather patterns across different locations. 9. Explore and visualize relationships between weather attributes, such as temperature and humidity, using correlation plots or heatmaps.
9	<p>Data Cleaning and Preparation</p> <p>Problem Statement: Analyzing Customer Churn in a Telecommunications Company</p> <p>Dataset: "Telecom_Customer_Churn.csv"</p> <p>Description: The dataset contains information about customers of a telecommunications company and whether they have churned (i.e., discontinued their services). The dataset includes various attributes of the customers, such as their demographics, usage patterns, and account information. The goal is to perform data cleaning and preparation to gain insights into the factors that contribute to customer churn.</p> <p>Tasks to Perform:</p> <ol style="list-style-type: none"> 1. Import the "Telecom_Customer_Churn.csv" dataset. 2. Explore the dataset to understand its structure and content. 3. Handle missing values in the dataset, deciding on an appropriate strategy. 4. Remove any duplicate records from the dataset. 5. Check for inconsistent data, such as inconsistent formatting or spelling variations, and standardize it. 6. Convert columns to the correct data types as needed. 7. Identify and handle outliers in the data. 8. Perform feature engineering, creating new features that may be relevant to predicting customer churn. 9. Normalize or scale the data if necessary.

	<p>10. Split the dataset into training and testing sets for further analysis.</p> <p>11. Export the cleaned dataset for future analysis or modeling.</p>
10	<p>Data Wrangling</p> <p>Problem Statement: Data Wrangling on Real Estate Market</p> <p>Dataset: "RealEstate_Prices.csv"</p> <p>Description: The dataset contains information about housing prices in a specific real estate market. It includes various attributes such as property characteristics, location, sale prices, and other relevant features. The goal is to perform data wrangling to gain insights into the factors influencing housing prices and prepare the dataset for further analysis or modeling.</p> <p>Tasks to Perform:</p> <ol style="list-style-type: none"> 1. Import the "RealEstate_Prices.csv" dataset. Clean column names by removing spaces, special characters, or renaming them for clarity. 2. Handle missing values in the dataset, deciding on an appropriate strategy (e.g., imputation or removal). 3. Perform data merging if additional datasets with relevant information are available (e.g., neighborhood demographics or nearby amenities). 4. Filter and subset the data based on specific criteria, such as a particular time period, property type, or location. 5. Handle categorical variables by encoding them appropriately (e.g., one-hot encoding or label encoding) for further analysis. 6. Aggregate the data to calculate summary statistics or derived metrics such as average sale prices by neighborhood or property type. 7. Identify and handle outliers or extreme values in the data that may affect the analysis or modeling process.
11	<p>Data Visualization using matplotlib</p> <p>Problem Statement: Analyzing Air Quality Index (AQI) Trends in a City</p> <p>Dataset: "City_Air_Quality.csv"</p> <p>Description: The dataset contains information about air quality measurements in a specific city over a period of time. It includes attributes such as date, time, pollutant levels (e.g., PM2.5, PM10, CO), and the Air Quality Index (AQI) values. The goal is to use the matplotlib library to create visualizations that effectively represent the AQI trends and patterns for different pollutants in the city.</p> <p>Tasks to Perform:</p> <ol style="list-style-type: none"> 1. Import the "City_Air_Quality.csv" dataset. 2. Explore the dataset to understand its structure and content. 3. Identify the relevant variables for visualizing AQI trends, such as date, pollutant levels, and AQI values. 4. Create line plots or time series plots to visualize the overall AQI trend over time. 5. Plot individual pollutant levels (e.g., PM2.5, PM10, CO) on separate line plots to visualize their trends over time. 6. Use bar plots or stacked bar plots to compare the AQI values across different dates or time periods. 7. Create box plots or violin plots to analyze the distribution of AQI values for different pollutant categories. 8. Use scatter plots or bubble charts to explore the relationship between AQI values and pollutant levels. 9. Customize the visualizations by adding labels, titles, legends, and appropriate color schemes.

<p>12 Data Aggregation</p> <p>Problem Statement: Analyzing Sales Performance by Region in a Retail Company</p> <p>Dataset: "Retail_Sales_Data.csv"</p> <p>Description: The dataset contains information about sales transactions in a retail company. It includes attributes such as transaction date, product category, quantity sold, and sales amount. The goal is to perform data aggregation to analyze the sales performance by region and identify the top-performing regions.</p> <p>Tasks to Perform:</p> <ol style="list-style-type: none"> 1. Import the "Retail_Sales_Data.csv" dataset. 2. Explore the dataset to understand its structure and content. 3. Identify the relevant variables for aggregating sales data, such as region, sales amount, and product category. 4. Group the sales data by region and calculate the total sales amount for each region. 5. Create bar plots or pie charts to visualize the sales distribution by region. 6. Identify the top-performing regions based on the highest sales amount. 7. Group the sales data by region and product category to calculate the total sales amount for each combination. 8. Create stacked bar plots or grouped bar plots to compare the sales amounts across different regions and product categories.
<p>13 Time Series Data Analysis</p> <p>Problem statement: Analysis and Visualization of Stock Market Data</p> <p>Dataset: "Stock_Prices.csv"</p> <p>Description: The dataset contains historical stock price data for a particular company over a period of time. It includes attributes such as date, closing price, volume, and other relevant features. The goal is to perform time series data analysis on the stock price data to identify trends, patterns, and potential predictors, as well as build models to forecast future stock prices.</p> <p>Tasks to Perform:</p> <ol style="list-style-type: none"> 1. Import the "Stock_Prices.csv" dataset. 2. Explore the dataset to understand its structure and content. 3. Ensure that the date column is in the appropriate format (e.g., datetime) for time series analysis. 4. Plot line charts or time series plots to visualize the historical stock price trends over time. 5. Calculate and plot moving averages or rolling averages to identify the underlying trends and smooth out noise. 6. Perform seasonality analysis to identify periodic patterns in the stock prices, such as weekly, monthly, or yearly fluctuations. 7. Analyze and plot the correlation between the stock prices and other variables, such as trading volume or market indices. 8. Use autoregressive integrated moving average (ARIMA) models or exponential smoothing models to forecast future stock prices.

Learning Resources

Text Books:

1. Ethem Alpaydin, "Introduction to Machine Learning", 2nd edition, PHI, 2013
2. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press, 2012
3. Chun-houh Chen, Wolfgang Härdle, Antony Unwin, "Handbook of Data Visualization", Springer
4. Ben Fry Beijing, "Visualizing Data", O'Reilly Media

- | | |
|----|---|
| 5. | McKinney W., "Python for Data Analysis: Data Wrangling with Pandas, NumPy and IPython", 2 nd edition, O'Reilly Media, 2017 |
| 6. | O'Neil, C., & Schutt, R., "Doing Data Science: Straight Talk from the Frontline", O'Reilly Media, 2013 |

Reference Books:

1. Ian H Witten, Eibe Frank, Mark A Hall, "Data Mining, Practical Machine Learning Tools and Techniques", 3rd edition, Elsevier
2. Jiawei Han, Micheline Kamber, and Jian Pie, "Data Mining: Concepts and Techniques", 3rd edition Elsevier Publishers, ISBN: 9780123814791, 9780123814807
3. Gelman, Andrew, and Jennifer Hill, "Data Analysis Using Regression and Multilevel/Hierarchical Models", 1st edition, Cambridge, UK: Cambridge University Press, 2006, ISBN: 9780521867061
4. Gelman, Andrew, John B. Carlin, Hal S. Stern, and Donald B. Rubin, "Bayesian Data Analysis", 2nd edition, New York, NY: Chapman & Hall, 2003, ISBN: 9781584883883
5. Gelman, Andrew, and Jennifer Hill, "Data Analysis Using Regression and Multilevel/Hierarchical Models", 1st edition, Cambridge, UK: Cambridge University Press, 2006, ISBN: 9780521867061

e-Resources:

1. Reinforcement Learning
https://www.cs.toronto.edu/~urtasun/courses/CSC411_Fall16/19_rl.pdf
2. An Introduction to Statistical Learning by Gareth James
<https://www.ime.unicamp.br/~dias/Intoduction%20to%20Statistical%20Learning.pdf>

e-Books:

1. A brief introduction to machine learning for Engineers: <https://arxiv.org/pdf/1709.02840.pdf>
2. Introductory Machine Learning Notes : <http://lcs.mit.edu/courses/ml/1718/MLNotes.pdf>
3. Python Data Science Handbook by Jake VanderPlas
<https://tanhiamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf>
4. Elements of Statistical Learning: data mining, inference, and prediction.
<https://hastie.su.domains/ElemStatLearn/index.html>

MOOC Courses:

1. Introduction to Machine Learning(IIT kharagpur) : <https://nptel.ac.in/courses/106105152>
2. Introduction to Machine Learning (IIT Madras):
https://onlinecourses.nptel.ac.in/noc22_cs29/prevew
3. Machine Learning A-Z™: AI, Python & R + ChatGPT Bonus [2023]
<https://www.udemy.com/course/machinelearning/>
4. Machine Learning and Deep Learning A-Z: Hands-On Python
<https://www.udemy.com/course/machine-learning-and-deep-learning-a-z-hands-on-pyt>
5. Introduction to Data Analytics
<https://nptel.ac.in/courses/110106072>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417526: Computer Laboratory II: Quantum AI

Teaching Scheme: PR: 04 Hours/Week	Credit 02	Examination Scheme and Marks Term Work (TW): 50 Marks Practical (PR): 25 Marks
--	----------------------------	---

Prerequisites Courses: Software Laboratory I (317523)

Companion Course: Elective III: Quantum AI (417523(A))

Course Objectives:

- To develop real-world problem-solving ability
- To enable the student to apply AI techniques in applications that involve perception, reasoning, and planning
- To work in a team to build industry-compliant Quantum AI applications

Course Outcomes:

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

CO1: Evaluate and apply core knowledge of Quantum AI to various real-world problems.

CO2: Illustrate and demonstrate Quantum AI tools for different dynamic applications.

Guidelines for Instructor's Manual

Lab Assignments: Following is a list of suggested laboratory assignments for reference. Laboratory Instructors may design a suitable set of assignments for their respective courses at their level. Beyond curriculum assignments, the mini-project is also included as a part of laboratory work. The Inclusion of a few optional assignments that are intricate and/or beyond the scope of the curriculum will surely be a valuable addition for the students and it will satisfy the intellectuals within the group of learners and will add to the perspective of the learners. For each laboratory assignment, it is essential for students to draw/write/generate flowcharts, algorithms, test cases, mathematical models, Test data sets, and comparative/complexity analysis (as applicable).

Guidelines for Student's Laboratory Journal

Program codes with sample output of all performed assignments are to be submitted as a softcopy. The use of DVDs or similar media containing student programs maintained by the Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journals may be avoided. Submission of journal/ term work in the form of softcopy is desirable and appreciated.

Guidelines for Laboratory/Term Work Assessment

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

Guidelines for Practical Examination

Problem statements must be decided jointly by the internal examiner and external examiner for Elective III and Elective IV courses. **Student has to perform only one practical assignment during external evaluation either for Elective III and Elective IV courses.** 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. Adhere to these principles will consummate our team efforts to the promising start of student's academics.

Guidelines for Laboratory Conduction

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

Instructions:

1. Practical can be performed on suitable development platform.
2. Perform any 5 experiments.

Virtual Laboratory

1. <https://learn.qiskit.org/course/quantum-hardware/introduction-to-quantum-error-correction-via-the-repetition-code>
2. <https://quantumcomputinguk.org/tutorials/16-qubit-random-number-generator>
3. <https://quantumcomputinguk.org/tutorials/quantum-fourier-transform-in-qiskit>
4. <https://www.sciencedaily.com/releases/2021/02/210212094105.htm>
5. <https://www.medrxiv.org/content/10.1101/2020.11.07.20227306v1.full>

List of Assignments

1. Implementations of 16 Qubit Random Number Generator
2. Tackle Noise with Error Correction
3. Implement Tarrataca's quantum production system with the 3-puzzle problem
4. Implement Quantum Teleportation algorithm in Python
5. The Randomized Benchmarking Protocol
6. Implementing a 5 qubit Quantum Fourier Transform

Learning Resources

Reference Books:

1. Nielsen, M. & Chuang I. "Quantum Computation and Quantum Information", 2002
2. Biamonte, J. et al., "Quantum Machine Learning", Nature, 2017
3. Rieffel, E. G., & Polak, W. H., "Quantum computing: A gentle introduction", MIT Press, 2011
4. Kaye, P., Laflamme, R., & Mosca, M., "An introduction to quantum computing", Rinton Press, 2007
5. Farhi, E., Goldstone, J., & Gutmann, S., "A quantum approximate optimization algorithm", arXiv preprint arXiv:1411.4028, 2014

MOOC Courses:

- <https://nptel.ac.in/courses/106106232>
- <https://www.coursera.org/learn/introduction-to-quantum-information>
- <https://www.udemy.com/topic/quantum-computing/>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417526: Computer Laboratory II: Industrial Internet of Things

Teaching Scheme: PR: 04 Hours/Week	Credit 02	Examination Scheme and Marks Term Work (TW): 50 Marks Practical (PR): 25 Marks
---	----------------------------	---

Prerequisites Courses: Internet of Things Laboratory (217531)

Companion Course: Elective III: Industrial Internet of Things (417523(B))

Course Objectives:

- To explore the needs and fundamental concepts of IIoT
- To elucidate the roles of sensors and protocols in IIoT
- To design and assemble IIOT system for various applications

Course Outcomes:

On completion of the course, learners will be able to—

CO1: Understand IIoT technologies, architectures, standards, and regulation

CO2: Build IIOT systems that include hardware and software and be exposed to modern and exciting hardware prototyping platforms

CO3: Develop real applications and improve them through smart technologies

Instructions:

1. Practical work can be performed on a suitable development platform (Arduino/ Raspberry pi)
2. Perform total 5 experiments.

Virtual Laboratory

1. <https://nielit.gov.in/node/12096>
2. <https://www.fp-lims.com/en/industrial-internet-of-things-iiot-lims/>

List of Assignments

1. Write a program for building a small-scale IIoT network using wireless communication protocols
2. Write a program for sending alert messages to the user for controlling and interacting with your environment.
3. Write an Arduino/ Raspberry pi program for interfacing with PIR sensor Experiment
4. Write a Program to design and develop a user interface for monitoring and controlling CPS system
5. Write a program for sending sensor data to the cloud and storing it in a database
6. Write a program for developing an IIoT application for energy monitoring and optimization
7. Write a program for implementing IIoT-enabled robotics and automation solutions
8. Write a program for implementing security measures in an IIoT system
9. Write a program for performing industrial data analysis using relevant tools and techniques

Learning Resources

Text Books:

1. Mahmood, Zaigham, "The Internet of Things in the Industrial Sector", Springer Publication
2. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, "Industrial Internet of Things: Cyber manufacturing System", Springer Publication
3. Ismail Butun, "Industrial IoT Challenges, Design Principles, Applications, and Security"

Reference Books:

1. R. Anandan, Suseendran Gopalakrishnan, Souvik Pal, Noor Zaman, "Industrial Internet of Things (IIoT): Intelligent Analytics for Predictive Maintenance", Wiley publication
2. S. Misra, C. Roy, and A. Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", CRC Press, 2020

e-Books:

1. How Protocol Conversion Addresses IIoT Challenges: White Paper ByRed Lion.
2. <https://www.ibm.com/topics/industry-4-0>
3. <https://www.wevolver.com/article/the-engineer-s-guide-to-industrial-iot-and-industry-4-0>

MOOC Courses:

1. https://onlinecourses.nptel.ac.in/noc20_cs69/preview
2. <https://www.coursera.org/specializations/developing-industrial-iot#courses>
3. <https://www.coursera.org/learn/industrial-internet-of-things>
4. <https://www.coursera.org/learn/internet-of-things-sensing-actuation>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417526: Computer Laboratory II: Enterprise Architecture and Components

Teaching Scheme: PR: 04 Hours/Week	Credit 02	Examination Scheme and Marks Term Work (TW): 50 Marks Practical (PR): 25 Marks
---	----------------------------	---

Companion Course: Elective III: Enterprise Architecture and Components (417523(C))

Course Objectives:

- Describe structure, components, and design of an organizations in EA related to Business and IT
- Select different tools for Enterprise Architecture Framework

Course Outcomes:

On completion of the course, learners will be able to—

CO1: Design Enterprise Architecture framework using tools

CO2: Build various reports based on Enterprise Architecture

Instructions:

1. Perform any 5 experiments.

List of Assignments

1. Write a short report on planning, securing, and governing the enterprise architecture.
2. Sketch enterprise architecture with emerging technologies such as cloud / IoT / AI / Blockchain.
3. Design and Implement enterprise architecture using TOGAF for banking/healthcare domain.
4. Develop an enterprise architecture using - IDEF, ARIS using Architecture Description Languages like SysML/piADL
5. Design enterprise security architecture using SABSA for Finance / Defense/Agriculture domain.
6. Design and implement an enterprise architecture framework for a hypothetical organization, considering the key components such as business architecture and technology architecture.
7. Design an enterprise information architecture that includes a detailed component model and operational model.
8. Generate a comprehensive report on open source Enterprise Architecture Tools - LeanIX Enterprise Architecture Management, ADOIT EA Suite, UPMX, Avolution ABACUS

Learning Resources

Text Books:

1. Philippe Desfray , Gilbert Raymond, Morgan Kaufmann, “Modeling Enterprise Architecture with TOGAF: A Practical Guide Using UML and BPMN”, 1st edition, 2014
2. Neal McWhorter, William Ulrich, “Business Architecture: The Art and Practice of Business Transformation”, Meghan-Kiffer Press

Reference Books:

1. Daniel Minoli, "Enterprise Architecture A to Z", Auerbach Publications, ISBN: 9781420013702
2. David Marco, Metadata Management for Information Control and Business Success", Wiley, 2013
3. Marc Lankhorst, "Enterprise Architecture at Work Modelling, Communication and Analysis", ISBN: 978-3-662-53933-0

e-Resources:

1. TOGAF: <https://www.opengroup.org/architecture/togaf8/downloads.htm>
2. SABSA: <https://sabsa.org/sabsa-matrices-2018-download-request/>
3. <https://www.dragon1.com/tutorials/how-to-create-an-enterprise-architecture-framework-diagram>
4. https://sparxsystems.com/downloads/whitepapers/enterprise_architecture_framework_design.pdf
5. <https://www.udemy.com/course/enterprise-architecture-how-to-design-models-diagrams/>
6. <https://www.g2.com/categories/enterprise-architecture-tools/free>
7. https://edisciplinas.usp.br/pluginfile.php/977101/course/section/268855/Seminar2_ADLS%20and%20Tools.pdf
8. https://www.kau.edu.sa/GetFile.aspx?id=191995&fn=CPIS352_Lect_05w05.pdf
9. <https://cs.emis.de/LNI/Proceedings/Proceedings160/309.pdf>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417526: Computer Laboratory II: Bioinformatics

Teaching Scheme: PR: 04 Hours/Week	Credit 02	Examination Scheme and Marks Term Work (TW): 50 Marks Practical (PR): 25 Marks
---	----------------------------	---

Prerequisites Courses: Statistics (217528), Artificial Intelligence (310253), Data Science (317529)

Companion Course: Elective III: Bioinformatics (417523(D))

Course Objectives:

- To refer appropriate, suitable datasets
- To study appropriate Bioinformatics tools

Course Outcomes:

On completion of the course, learners will be able to

CO1: Use suitable datasets for various problems

CO2: Demonstrate and apply appropriate Bioinformatics tools

Instructions:

1. Practical can be performed on suitable development platform.
2. Perform total 4 experiments (Group A) and one mini-project (Group B)

List of Assignments

1. Assignment: DNA Sequence Analysis. Task: Analyze a given DNA sequence and perform basic sequence manipulation, including finding motifs, calculating GC content, and identifying coding regions. Deliverable: A report summarizing the analysis results and any insights gained from the sequence.
2. Assignment: RNA-Seq Data Analysis. Task: Analyze a provided RNA-Seq dataset and perform differential gene expression analysis. Deliverable: A detailed report presenting the differentially expressed genes, their functional annotations, and any potential biological interpretations
3. Assignment: Protein Structure Prediction. Task: Predict the 3D structure of a given protein sequence using homology modeling or threading techniques. Deliverable: A report presenting the predicted protein structure, along with an analysis of its potential functions and interactions.
4. Assignment: Molecular Docking and Virtual Screening. Task: Perform molecular docking simulations to predict the binding affinity between a protein target and a small molecule ligand. Additionally, conduct virtual screening to identify potential drug candidates. Deliverable: A report summarizing the docking results, including the binding poses and potential lead compounds.
5. Assignment: Machine Learning for Genomic Data. Task: Apply machine learning algorithms, such as random forests or support vector machines, to classify genomic data based on specific features or markers. Deliverable: A comprehensive analysis report presenting the classification results, model performance evaluation, and insights into the predictive features.
6. Assignment: Agricultural Genomics and Crop Improvement. Task: Analyze genomic data from crops to identify genetic markers associated with desirable traits, such as disease resistance or yield. Deliverable: A research poster summarizing the analysis methodology, key findings, and potential applications in crop improvement.

Learning Resources

Text Books:

1. S.C. Rastogi et. al., "Bioinformatics- Concepts, Skills, and Applications", 2nd edition, CBS Publishing, 2016, ISBN: 9788123914824
2. Cynthia Gibas and Per Jambeck, "Developing Bioinformatics Computer Skills", O'Reilly press, Shorff Publishers and Distributors Pvt. Ltd., 2001

Reference Books:

1. Jean-Michel Claverie and Cedric Notredame, "Bioinformatics – A Beginners Guide" , Wiley – Dreamtech India Pvt. Ltd., 2003
2. Zoe' Lacroix and critchlow, "Bioinformatics: Managing scientific data", Morgan Kaufmann Publishers, 2004
3. Campbell AM and Heyer LJ, "Discovering Genomics, Proteomics and Bioinformatics", Pearson Education, 2003

e-Books:

1. <http://www.bioinformatics.org/>
2. <http://www.bioinfo.mbb.yale.edu/mbb452a/intro/>

MOOC Courses:

1. <https://archive.nptel.ac.in/courses/102/106/102106065/>
2. <https://www.udemy.com/course/genetics-and-next-generation-sequencing-forbioinformatics/>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417526: Computer Laboratory II: GPU Programming and Architecture

Teaching Scheme: PR: 04 Hours/Week	Credit 02	Examination Scheme and Marks Term Work (TW): 50 Marks Practical (PR): 25 Marks
---	----------------------------	---

Prerequisites Courses: OOP and Computer Graphics Lab. (217523)

Companion Course: Elective IV: GPU Programming and Architecture (417524(A))

Course Objectives:

- To learn the fundamentals of GPU Computing in the CUDA environment.
- To understand and implement parallel searching algorithms.
- To understand and implement parallel sorting algorithms

Course Outcomes:

After completion of the course, learners will be able to-

CO1: Analyze and measure performance of sequential and parallel algorithms.

CO2: Design and Implement solutions for multicore/parallel environment.

CO3: Identify and apply the suitable algorithms to solve real life problems

Instructions:

1. Practical can be performed on suitable development platform.
2. Perform any 5 experiments.

List of Assignments

1. Write a CUDA program for dot product and calculation of pi using integration method
2. Write a CUDA program for Addition of two large vectors
3. Write a CUDA program for matrix transpose and matrix multiplication
4. Write a program using OpenCL to display “Hello World”
5. Write a program using OpenCL for Heterogeneous computing
6. Develop a program using combining abilities of OpenGL and CUDA to accelerate the performance of simple graphics.

Learning Resources

Text Books:

1. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, "Introduction to Parallel Computing", 2nd edition, Addison-Wesley, 2003, ISBN: 0-201-64865-2
2. Aaftab Munshi, Benedict R. Gaster, Timothy G. Mattson, James Fung, Dan Ginsburg "OpenCL Programming Guide", Addison-Wesley, 2011, ISBN: 9780132488006
3. John Cheng, Max Grossman, and Ty McKercher, "Professional CUDA C Programming", John Wiley & Sons, Inc., ISBN: 978-1-118-73932-7

Reference Books:

1. Seyed H. Roosta, "Parallel Processing and Parallel Algorithms Theory and Computation", Springer-Verlag 2000, ISBN 978-1-4612-7048-5
2. Jason Sanders, Edward Kandrot, "CUDA by Example: An Introduction to General Purpose GPU Programming", Addison – Wesley, 2010
3. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, "Heterogeneous computing with OpenCL", 3rd edition, Morgan Kauffman, 2015

e-Books:

1. https://edoras.sdsu.edu/~mthomas/docs/cuda/cuda_by_example.book.pdf
2. <https://www.cs.utexas.edu/~rossbach/cs380p/papers/cuda-programming.pdf>
3. <https://www.syncfusion.com/succinctly-free-ebooks/confirmation/cuda>
4. <https://ptgmedia.pearsoncmg.com/images/9780321749642/samplepages/0321749642.pdf>

MOOC Courses:

1. https://onlinecourses.nptel.ac.in/noc20_cs41/preview
2. <https://www.coursera.org/specializations/gpu-programming>
3. <https://www.udemy.com/course/cuda-gpu-programming-beginner-to-advanced/>

The CO-PO Mapping Matrix

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

<p style="text-align: center;">Savitribai Phule Pune University</p> <p style="text-align: center;">Fourth Year of Artificial Intelligence and Data Science (2020 Course)</p> <p style="text-align: center;">417526: Computer Laboratory II: Information Retrieval</p>																						
Teaching Scheme: PR: 04 Hours/Week			Credit 02			Examination Scheme and Marks Term Work (TW): 50 Marks Practical (PR): 25 Marks																
Companion Course: Elective IV: Information Retrieval (417524(B))																						
<p>Course Objectives:</p> <ul style="list-style-type: none"> • Understand the concepts of information retrieval and web mining • Understand information retrieval process using standards available tools 																						
<p>Course Outcomes:</p> <p>CO1: Apply various tools and techniques for information retrieval and web mining</p> <p>CO2: Evaluate and analyze retrieved information</p>																						
<p>Instructions: Perform any 5 assignments.</p>																						
List of Assignments																						
<p>1. Write a program for pre-processing of a text document such as stop word removal, stemming.</p> <p>2. Implement a program for retrieval of documents using inverted files.</p> <p>3. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using the standard Heart Disease Data Set (You can use Java/Python ML library classes/API).</p> <p>4. Implement e-mail spam filtering using text classification algorithm with appropriate dataset.</p> <p>5. Implement Agglomerative hierarchical clustering algorithm using appropriate dataset.</p> <p>6. Implement Page Rank Algorithm. (Use python or beautiful soup for implementation).</p> <p>7. Build the web crawler to pull product information and links from an e-commerce website.</p>																						
Learning Resources																						
<p>Text Books:</p> <ol style="list-style-type: none"> 1. C. Manning, P. Raghavan, and H. Schütze, “Introduction to Information Retrieval”, Cambridge University Press, 2008 2. Ricardo Baeza-Yates, Berthier Riberio-Neto, “Modern Information Retrieval”, Pearson Education, ISBN: 81-297-0274-6 3. C.J. Rijsbergen, “Information Retrieval”, 2nd edition, ISBN: 978-408709293 4. Ryan Mitchell, “Web Scraping with Python”, O’reilly 																						
<p>Reference Books:</p> <ol style="list-style-type: none"> 1. S. Buttcher, C. Clarke and G. Cormack, “Information Retrieval: Implementing and Evaluating Search Engines” MIT Press, 2010, ISBN: 0-408-70929-4 2. Amy N. Langville and Carl D. Meyer, “Google’s PageRank and Beyond: The Science of Search Engine Rankings”, Princeton University Press, ISBN: 9781400830329 																						
<p>e-Books:</p> <ol style="list-style-type: none"> 1. http://nlp-iiith.vlabs.ac.in/ 																						
The CO-PO Mapping Matrix																						
CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12										
CO1	1	1	2	3	2	-	-	-	-	-	-	1										
CO2	1	1	2	3	2	-	-	-	-	-	-	1										

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417526: Computer Laboratory II: UI /UX Design

Teaching Scheme: PR: 04 Hours/Week	Credit 02	Examination Scheme and Marks Term Work (TW): 50 Marks Practical (PR): 25 Marks
--	---------------------	---

Prerequisites Courses: Human Computer Interface (310245(B))

Companion Course: Elective IV: User Experience Design (417524(C))

Course Objectives:

- To study various tools of UI/UX Design
- To develop skills in creating visually appealing and cohesive user interfaces.
- To learn to conduct usability testing and evaluation
- To understand the role of prototyping in the design process
- To study collaborative features of UI/ UX Tool
- To gain awareness of ethical considerations in UI/UX design

Course Outcomes:

On completion of the course, learners will be able to—

- CO1:** Apply user-centered design methodologies
CO2: Create effective user interfaces / user experiences
CO3: Develop proficiency in design tools
CO4: Design for multiple platforms and devices
CO5: Conduct usability testing and analysis
CO6: Develop a portfolio of UI/UX design projects

Instructions:

1. Practical can be performed on suitable development platform.
2. Perform any 5 experiments.

List of Assignments

Group A

1. Design user persona for the users of selected product / system.
 - II. [How To Create A User Persona \(Video Guide\) - YouTube](#)
 - III. [How to Create A User Persona in 2022 \[FULL GUIDE\] - YouTube](#)
2. Online Learning Platform: Design a wireframe for an online learning platform that includes course listings, video lectures, quizzes, and progress tracking.
 - I. [E-learning Website Design in Figma - YouTube](#)
3. Designing a Social Fitness App: Create wireframes and a prototype for a social fitness app that allows users to track workouts, connect with friends, and share progress.

Design the user interface for logging exercises, setting goals, and incorporating social features.

 - I. [Fitness App Design In Figma || Figma Tutorial || Design & Prototyping - YouTube](#)

4. Product Packaging Mockup: Choose a product and create a mockup of its packaging design. Use a mockup tool that specializes in packaging design or graphic design. Design the product packaging, including the layout, colors, logos, and product visuals. Showcase the packaging design from different angles and perspectives.

- I. Poster or Flyer Mockup: Select a specific event, campaign, or promotional material. Design a poster or flyer using a graphic design tool with mockup capabilities. Create a visually appealing mockup of the poster or flyer in different sizes and formats. Showcase the design within a realistic environment or context, such as a wall or display.

5. Use Figma tool to Design a user interface for a recipe finder application, allowing users to search for recipes based on ingredients, categories, and dietary restrictions. Include features like recipe details, cooking instructions, and saving favorites.

- I. [Create a Food & Drink Recipe app with reviews from Figma no code - YouTube](#)

6. Use Figma tool for Improving the User Interface of a Fitness Tracking App: Improve the user interface of an existing fitness tracking app by focusing on simplicity, clarity, and motivational elements. Enhance features like tracking workouts, setting goals, and visualizing progress to create a more engaging and intuitive experience.

- I. [Figma Fitness mobile app Design | design a Fitness app in Figma | UIUX Design 2021 | Techno-fine - YouTube](#)

7. Collaborative Design Exercise:

Form a design team and work on a collaborative design project using Figma. Assign different design tasks to team members, such as wireframing, visual design, or prototyping. Utilize Figma's collaboration features to work together in real-time. Coordinate and provide feedback to each other to refine and improve the design.

[Create Teams in Figma & Real-Time Collaboration in Figma for Designers - YouTube](#)

8. Usability Testing Simulation: Develop a high-fidelity interactive prototype using any UI/UX tool. Prepare a usability testing plan, recruit participants, and simulate usability testing sessions. Analyze the feedback and iterate on the design based on the insights gathered during the testing.

[Usability Testing in UX Design Thinking Process - YouTube](#)

Learning Resources

Text Books:

1. Creative Tim, "Fundamentals of Creating a Great UI/UX", 1st Edition
2. Jon Yablonski, "Laws of UX: Using Psychology to Design Better Products & Services" , O'REILLY Publication
3. Jenifer Tidwell, Charles Brewer, Aynne Valencia "Designing Interfaces: Patterns for Effective Interaction Design", O'REILLY Publication

Reference Books:

1. Shneiderman, Plaisant, Cohen, Jacobs, "Designing the User Interface-Strategies for Effective Human Computer Interaction", 5th edition, PEARSON Publication
2. Wilbert O. Galitz "The Essential Guide to User Interface Design", 2nd Edition, WILEY Publication
3. Alan Dix, Janet Finlay, Gregory D. Abowd, Russell Beale, "Human–Computer Interaction, 3rdEdition,
4. Alan Coopon, "The essentials of interaction"

MOOC Courses:

1. Uset Interface Design: https://onlinecourses.nptel.ac.in/noc21_ar05/preview

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417526: Computer Laboratory II: Optimization Algorithms

Teaching Scheme: PR: 04 Hours/Week	Credit 02	Examination Scheme and Marks Term Work (TW): 50 Marks Practical (PR): 25 Marks
---	----------------------------	---

Companion Course: Elective IV: Optimization Algorithms (417524(D))

Course Objectives:

- Understand different optimization techniques
- To make an effective use of optimization techniques in real time problem solving
- Analyze the performance of the algorithm

Course Outcomes:

On completion of the course, learners will be able to—

CO1: Model different optimization techniques and analyze the performances of an algorithm developed/used

CO2: Improving the efficiency of an algorithm through feature selection

CO3: Tuning the parameters of an algorithm for better throughput

Instructions:

1. Practical can be performed on suitable development platform.
2. Perform any 9 assignments (from 1 to 11: 8th and 9th is compulsory) and one mini project

Virtual Laboratory

1. <https://niet.gov.in/node/12096>

List of Assignments

Group A

1. A mechanical industry has three warehouses in the Solapur area and needs to deliver camshafts to its three shops in and around for tomorrow. The three shops demand 10, 20, and 40 units respectively. The current stock level of shafts in the three warehouses are 80, 62, and 32 respectively. Delivery costs from each warehouse to each store are different due to different distances. Find the least expensive way to deliver the chairs to the stores. The delivery cost matrix is represented below. Use Linear Programming to write a program in python.

	Shop 1	Shop 2	Shop 3
Warehouse 1	3000/-	2000/-	5000/-
Warehouse 2	2000/-	7000/-	3000/-
Warehouse 3	2200/-	2400/-	1000/-

2. Write a python program to maximize the function $f(x) = 2x_1 + 3x_2 - x_1^2 + x_2^2$ with constraints $x_1 + x_2 \leq 3$ and $2x_1 + 3x_2 \leq 4$ find out the values of x_1 and x_2 such that it maximizes the given objective function $f(x)$ using Quadratic Programming

3. A linear equation of the form $aX_1 + bX_2 + cX_3 + dX_4 = T$ is to be solved with the help of Genetic Algorithms applying Initialize population, Fitness Evaluation, Reproduction, Crossover and Mutation. Find out the approximate values of the coefficients a, b, c and d with python programming

4. There is a dataset **D** over $R^{m \times n}$, supplied to the machine learning algorithm for classification purposes. We are cautious about the selection of the attributes for training and testing the model. Use Particle Swarm Optimization for feature selection and show that the performance of a classification algorithm is improved over the use of PSO.

5. A Binary Particle Swarm Optimization algorithm to be applied on a dataset **D** for selection of the features to be used for training a binary class classifier. Mine the performance of the classifier when Binary PSO is applied.

6. Mini Project: Design and develop a mini project for classification of images into different categories using CNN along with Particle Swarm Optimization/Firefly/Binary PSO. The group of students developing this application need to use different datasets. Priority must be given for self-data creation, publishing and using it in this project.

Learning Resources

Text Books:

1. Andreas Antoniou and Wu-Sheng Lu, “Practical optimization Algorithms and Engineering Applications”, Springer
2. Xin-She Yang, “Nature-Inspired Optimization Algorithms”, Elsevier Publication
3. Rajesh Kumar Arora, “Optimization Algorithms and Applications” CRC Press Taylor & Francis Group
4. Nature-Inspired Optimization Algorithms- A Vasuki by CRC Press

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417527: Project Stage I

Teaching Scheme: PR: 04 Hours/Week	Credit 02	Examination Scheme: Term Work: 50 Marks Presentation: 50Marks
---	----------------------------	--

Course Objectives:

- To Apply the knowledge for solving realistic problem
- To develop problem solving ability
- To Organize, sustain and report on a substantial piece of team work over a period of several months
- To Evaluate alternative approaches, and justify the use of selected tools and methods
- To Reflect upon the experience gained and lessons learned
- To Consider relevant social, ethical and legal issues
- To find information for yourself from appropriate sources such as manuals, books, research journals and from other sources, and in turn increase analytical skills
- To Work in team and learn professionalism

Course Outcomes:

On completion of the course, student will be able to—

CO1: Solve real life problems by applying knowledge

CO2: Analyze alternative approaches, apply and use most appropriate one for feasible solution

CO3: Write precise reports and technical documents in a nutshell

CO4: Participate effectively in multi-disciplinary and heterogeneous teams exhibiting team work

CO5: Inter-personal relationships, conflict management and leadership quality

Guidelines

Project work Stage – I is an integral part of the Project work. In this, the student shall complete the partial work of the Project which will consist of problem statement, literature review, SRS, Model and Design. The student is expected to complete the project at least up to the design phase. As a part of the progress report of project work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected project topic. The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute. The examinee will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on work undergone, content delivery, presentation skills, documentation, question-answers and report.

Follow guidelines and formats as mentioned in Project Workbook recommended by Board of Studies

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417528: MOOC

Teaching Scheme: TUT: 02 Hours/Week	Credit 02	Examination Scheme: Term Work: 50 Marks
--	----------------------------	--

Course Objectives:

- To promote interactive user forums to support community interactions among students, professors, and experts
- To promote learn additional skills anytime and anywhere
- To enhance teaching and learning on campus and online

Course Outcomes:

After completion of the course, learners should be able to-

CO1: To acquire additional knowledge and skill

CO2: Explore new areas of interest in a relevant field

Course Contents

MOOCs (Massive Open Online Courses) provide affordable and flexible ways to learn new skills, pursue lifelong interests and deliver quality educational experiences at scale. Whether you're interested in learning for yourself, advancing your career or leveraging online courses to educate your workforce, SWAYAM, NPTEL, edx or similar ones can help. World's largest SWAYAM MOOCs, a new paradigm of education for anyone, anywhere, anytime, as per your convenience, aimed to provide digital education free of cost and to facilitate hosting of all the interactive courses prepared by the best more than 1000 specially chosen faculty and teachers in the country. SWAYAM MOOCs enhance active learning for improving lifelong learning skills by providing easy access to global resources. SWAYAM is a programme initiated by the Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy. This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses. The courses hosted on SWAYAM are generally in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multimedia and state of the art pedagogy / technology. In order to ensure best quality content is produced and delivered, seven National Coordinators have been appointed: They are NPTEL for engineering and UGC for post-graduation education. Guidelines: Instructors are requested to promote students to opt for courses (not opted earlier) with proper mentoring. The departments will take care of providing necessary infrastructural and facilities for the learners. Learning can also be more interesting by knowledge sharing through different blogs, learning communities and social media platforms.

References:

1. <https://swayam.gov.in/>
2. <https://onlinecourses.nptel.ac.in/>
3. <https://www.edx.org>
4. <https://www.mygreatlearning.com/academy>
5. <https://www.simplilearn.com>

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

- | | |
|---|---|
| <ul style="list-style-type: none"> • Lectures/ Guest Lectures • Visits (Social/Field) and reports • Demonstrations | <ul style="list-style-type: none"> • Surveys • Mini-Project • Hands on experience on focused topic |
|---|---|

A report of 15-20 pages contains any of the activity details mentioned above.

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417529: Audit Course 7

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 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.

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

- | | |
|--|---|
| <ul style="list-style-type: none"> • Lectures/ Guest Lectures • Visits (Social/Field) and reports • Demonstrations or presentations | <ul style="list-style-type: none"> • 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
- Presentation or Report

Audit Course 7 Options

Audit Course Code	Audit Course Title
AC7-I	Block Chain
AC7-II	Entrepreneurship Development
AC7-III	Botnet of Things
AC7-IV	Foreign Language
AC7-V	MOOC-Learn New Skills

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417529: Audit Course 7
AC7-I: Block Chain

Course Objectives:

- Imparting knowledge of block chain methods and being able to deliver the topics in a systematic and straightforward manner
- To get knowledgeable about emerging currencies and to develop one's own crypto token or NFTGram

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Able to know how to use current currencies in the market

CO2: Analyze the applications for block chains in a structured way

CO3: Comprehensively elucidate contemporary block chain technology principles

Course Contents

1. **Introduction to Block chain:** Distributed DBMS – Limitations of Distributed DBMS, Introduction to Block chain – History, Definition, Distributed Ledger, Blockchain Categories – Public, Private, Consortium, Blockchain Network and Nodes, Peer-to-Peer Network, Mining Mechanism, Generic elements of Blockchain, Features of Blockchain, and Types of Blockchain.
2. **Block Chain Architecture:** Operation of Bitcoin Blockchain, Blockchain Architecture – Block, Hash, Distributer P2P, Structure of Blockchain- Consensus mechanism: Proof of Work (PoW), Proof of Stake (PoS).
3. **Cryptography Algorithms:** Introduction to cryptography-Encryption and Decryption- Ciphers-Cryptography using arithmetic modulo primes-hashing algorithms-SHA-256 algorithm-Application of SHA algorithm.
4. **Cryptocurrency and Etherium:** Building Your Own Cryptocurrency- Compiling Bitcoin from source- New cryptocurrency – Readercoin: Cloning Bitcoin, Readercoin rebranding- Peer-to-Peer Auctions in Ethereum: Introduction to Ethereum.

Case Study

Blockchain in Supply Chain

Blockchain in Manufacturing

Blockchain in Automobiles

Blockchain in Healthcare

Blockchain in Cyber security

Blockchain in Financial Industry

Blockchain with IOT: Create two Ether accounts and perform transactions using Metamask Wallet and analyze the gas consumption.

Blockchain with AI: Deployment of Cryptocurrencies & Predictions using AI

Text Books:

1. Narayanan, Bonneau, Felten, Miller and Goldfeder, "Bitcoin and Cryptocurrency Technologies – A Comprehensive Introduction", Princeton University Press
2. Josh Thompson, "Blockchain: The Blockchain for Beginnings, Guide to Blockchain Technology and Blockchain Programming", Create Space Independent Publishing Platform, 2017
3. Imran Bashir, "Mastering Blockchain: Distributed ledger technology, decentralization, and smart contracts explained", Packt Publishing

References:

1. Merunas Grincalaitis, "Mastering Ethereum: Implement Advanced Blockchain Applications Using Ethereum-supported Tools, Services, and Protocols", Packt Publishing

MOOC Courses:

1. Prof. Sandip Chakraborty, Dr. Praveen Jayachandran, "Blockchain Architecture Design and Use Cases" [MOOC], NPTEL: <https://nptel.ac.in/courses/106/105/106105184/>
2. Udemy course: Blockchain - Complete Blockchain Course for Beginners

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

- | | |
|---|---|
| <ul style="list-style-type: none">• Lectures/ Guest Lectures• Visits (Social/Field) and reports• Demonstrations | <ul style="list-style-type: none">• Surveys• Mini-Project• Hands on experience on focused topic |
|---|---|

A report of 15-20 pages contains any of the activity details mentioned above.

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417529: Audit Course 7
AC7-II: Entrepreneurship Development

Course Objectives:

- Develop Entrepreneurial Thinking: Foster an entrepreneurial mindset among students, enabling them to think creatively, identify opportunities, and embrace calculated risk-taking
- Understand Business Planning: Equip students with the knowledge and skills to develop comprehensive business plans and create value propositions
- Foster Innovation and Product Development: Cultivate students' ability to apply innovation principles, navigate the product development lifecycle, and continuously improve their products or services
- Develop Leadership and Management Skills: Enhance students' leadership capabilities by focusing on effective communication, team building, decision-making, and problem-solving skills necessary for leading and managing a startup

Course Outcomes:

After completion of the course, learners should be able to-

- CO1:** Develop an understanding of startup eco system and entrepreneurial mindset and its significance in the economy
- CO2:** Create a comprehensive business plan by conducting market research, defining target markets, and designing a value proposition
- CO3:** Evaluate different funding sources and develop financial management skills necessary for startup success
- CO4:** Formulate effective marketing strategies and sales techniques to target specific customer segments
- CO5:** Develop leadership and management skills necessary for leading teams and making informed decisions
- CO6:** Apply innovation and product development concepts to create and refine products or services

Course Contents**1. Introduction to Entrepreneurship:**

Understanding the entrepreneurial mindset, Importance of entrepreneurship in the economy, identifying opportunities and generating ideas, Exploring different types of entrepreneurship (social, tech, etc.)

Case study: *Expert session from Industry, academia and integrate college incubation center activities in collaboration with SPPU incubation center*

2. Introduction to Entrepreneurship:

Understanding the entrepreneurial mindset, Importance of entrepreneurship in the economy, identifying opportunities and generating ideas, Exploring different types of entrepreneurship (social, tech, etc.)

Case study: *Expert session from Industry, academia and integrate college incubation center activities in collaboration with SPPU incubation center*

3. Introduction to Entrepreneurship:

Understanding the entrepreneurial mindset, Importance of entrepreneurship in the economy, identifying opportunities and generating ideas, Exploring different types of entrepreneurship (social, tech, etc.)

Case study: *Expert session from Industry, academia and integrate college incubation center activities in collaboration with SPPU incubation center*

4. Business Planning:

Developing a business plan, conducting market research and analysis, defining target market and positioning, understanding competitive landscape, Creating a value proposition and revenue model. **Case study:** Expert session from Alumni and incubator

5. Funding and Finance:

Identifying different funding sources (bootstrapping, angel investors, venture capital, crowdfunding), Financial management and budgeting, Valuation and equity distribution, Managing cash flow and financial projections

link : <https://msme.gov.in/incubation>

6. Marketing and Sales:

Developing a marketing strategy, Branding and positioning, Market segmentation and targeting, Digital marketing and social media strategies, Sales techniques and customer acquisition

7. Innovation and Product Development:

Design thinking and idea generation, Product development lifecycle, Minimum Viable Product (MVP) concept, User experience and usability testing, Iterative development and continuous improvement. **Case study of AI Chatbot application.**

8. Leadership and Management:

Leadership styles and traits, Effective communication and negotiation, Team building and motivation, Decision-making and problem-solving, managing conflicts and embracing diversity

link: <https://www.startupindia.gov.in/content/sih/en/ams-application/incubator-program.html?applicationId=5f06b1dde4b0f2b258378ee9>

References:

- Eric Ries, “The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses”
- Alexander Osterwalder and Yves Pigneur, “Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers”
- by Steve Blank and Bob Dorf, “The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company”

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

- | | |
|---|---|
| <ul style="list-style-type: none"> • Lectures/ Guest Lectures • Visits (Social/Field) and reports • Demonstrations | <ul style="list-style-type: none"> • Surveys • Mini-Project • Hands on experience on focused topic |
|---|---|

A report of 15-20 pages contains any of the activity details mentioned above.

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417529: Audit Course 7
AC7-III: Botnet of Things

Course Objectives:

- To Understand the various IoT Protocols
- To Understand the IoT Reference Architecture and Real-World Design Constraints
- To learn the concept of Botnet

Course Outcomes:

After completion of the course, learners should be able to-

- CO1:** Implement security as a culture and show mistakes that make applications vulnerable to attacks
- CO2:** Understand various attacks like DoS, buffer overflow, web specific, database specific, web - spoofing attacks
- CO3:** Demonstrate skills needed to deal with common programming errors that lead to most security problems and to learn how to develop secure applications

Course Contents

1. **Introduction:** Internet Relay Chat (IRC), DorkBot, RageBot, Phorpiex, and IRCBot.HI.
2. **IRC-Based Bot Networks:** Anatomy of a Botnet, Packet sniffer, Keylogger, Polymorphic code, Rootkit installer, Information harvest, SMTP Client Spam, HTTP client Click Fraud, Remote Buffer Overflow.
3. Anatomy of a Botnet: The Gaobot Worm
4. **IoT Sensors and Security:** Sensors and actuators in IoT, Communication and networking in IoT, Real-time data collection in IoT, Data analytics in IoT , IoT applications and requirements, Security threats and techniques in IoT, Data trustworthiness and privacy in IoT, Balancing utility and other design goals in IoT , Future of Botnets in the Internet of Things, Thingbots, Elements of Typical IRC Bot Attack , Malicious use of Bots and Botnet
5. **Service Layer Protocols and Security:** Security: PHP Exploits, Cross-Site Scripting and Other Browser-Side Exploits, Bots and Botnets, Service Layer -oneM2M, ETSI M2M, OMA, BBF –Security in IoT Protocols –MAC 802.15.4 , 6LoWPAN, RPL, Application Layer Transport and Session layer protocols- transport Layer (TCP, MPTCP, UDP, DCCP, SCTP) - (TLS, DTLS) – Session Layer - HTTP, CoAP, XMPP, AMQP, MQTT

Text Books:

1. Bernd Scholz - Reiter, Florian Michahelles, “Architecting the Internet of Things”, Springer ISBN 978 – 3 – 642 – 19156 - 5 e - ISBN 978-3-642-19157-2
2. Frank Swiderski and Window Snyder, “Threat Modeling”, Microsoft Professional, 1st edition, 2004

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

- | | |
|---|---|
| <ul style="list-style-type: none"> ● Lectures/ Guest Lectures ● Visits (Social/Field) and reports ● Demonstrations | <ul style="list-style-type: none"> ● Surveys ● Mini-Project ● Hands on experience on focused topic |
|---|---|

A report of 15-20 pages contains any of the activity details mentioned above.

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417529: Audit Course 7
AC7-IV: Foreign Language

Course Objectives:

- Get introduced to the Culture, Routine of the Foreign Society through language
- Meet the needs of ever growing foreign industry with respect to language support

Course Outcomes:

After completion of the course, learners-

CO1: Will have the ability of basic communication

CO2: Will have the knowledge of Language script

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

CO4: Will develop interest to pursue profession in Foreign Industry

Course Contents**Instructions:**

All course contents should be completed in only one language (German, French, Japanese and any other suitable foreign language)

1. **Introduction to the Foreign Language:** Introduction of Alphabets, Spell the names, Addresses, Numbers, Telephone numbers, OrdinalNumbers, Pin code Numbers, Dates, Birthdates, Age, days of the week, Months.
2. **Communication Part 1:** Basic Greetings, Personal Pronouns, Possessive Pronouns.
3. **Communication Part 2:** Self-Introduction, Introducing other people, about family, friends, course mates, seasons, and seasons in Other countries and in neighboring countries.

Text Books:

1. The Everything Learning German Book: Speak, write, and understand basic German in no time (Everything®) Kindle Edition with Audio/Video by Edward Swick (Author)
2. NETZWERK Deutsch als Fremdsprache A1(Goyal, New Delhi, 2015)
3. Japanese from Zero!, Book 1 by George Trombley, Yukari Takenaka

References:

1. Best Books for Learning French By David Issokson
2. Easy Spanish Step-By-Step By Barbara Bregstain

MOOC Courses:

1. [https://onlinecourses.nptel.ac.in/noc21_hs30/preview](https://onlinecourses.nptel.ac.in/noc21_hs30/)
2. <https://nptel.ac.in/courses/109106166>
3. <https://nptel.ac.in/courses/109106085>

e-Resources:

1. <https://www.coursera.org/browse/language-learning>
2. https://alison.com/?utm_source=google&utm_medium=cpc&utm_campaign=PPC_Tier-4_First-Click_Courses-Broad_&utm_adgroup=Product_Courses&gclid=CjwKCAjwhdWkBhBZEiwA1ibLmIZPl30Tg6Zd7UDPSU2vcB2J1doDOAi9SnBCElqJWK2_Hhdfo2iCSRoCGwkQAvD_BwE
3. FACTS ABOUT GERMANY <https://www.tatsachen-ueber-deutschland.de/en>
4. ONLINE GERMAN-ENGLISH DICTIONARY www.leo.org
5. PRACTICE MATERIAL <https://www.goethe.de/en/spr/kup/prf/prf/sd1/ueb.html>

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

- | | |
|---|---|
| <ul style="list-style-type: none"> ● Lectures/ Guest Lectures ● Visits (Social/Field) and reports ● Demonstrations | <ul style="list-style-type: none"> ● Surveys ● Mini-Project ● Hands on experience on focused topic |
|---|---|

A report of 15-20 pages contains any of the activity details mentioned above.

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417529: Audit Course 7
AC7-V: MOOC-Learn New Skills

Course Objectives:

- To promote interactive user forums to support community interactions among students, professors, and experts
- To promote learn additional skills anytime and anywhere
- To enhance teaching and learning on campus and online

Course Outcomes:

After completion of the course, learners should be able to-

CO1: To acquire additional knowledge and skill

CO2: Explore new areas of interest in a relevant field

Course Contents

MOOCs (Massive Open Online Courses) provide affordable and flexible ways to learn new skills, pursue lifelong interests and deliver quality educational experiences at scale. Whether you're interested in learning for yourself, advancing your career or leveraging online courses to educate your workforce, SWAYAM, NPTEL, edx or similar ones can help. World's largest SWAYAM MOOCs, a new paradigm of education for anyone, anywhere, anytime, as per your convenience, aimed to provide digital education free of cost and to facilitate hosting of all the interactive courses prepared by the best more than 1000 specially chosen faculty and teachers in the country. SWAYAM MOOCs enhance active learning for improving lifelong learning skills by providing easy access to global resources. SWAYAM is a programme initiated by the Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy. This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses. The courses hosted on SWAYAM are generally in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multimedia and state of the art pedagogy / technology. In order to ensure best quality content is produced and delivered, seven National Coordinators have been appointed: They are NPTEL for engineering and UGC for post-graduation education. Guidelines: Instructors are requested to promote students to opt for courses (not opted earlier) with proper mentoring. The departments will take care of providing necessary infrastructural and facilities for the learners. Learning can also be more interesting by knowledge sharing through different blogs, learning communities and social media platforms.

References:

1. <https://swayam.gov.in/>
2. <https://onlinecourses.nptel.ac.in/>
3. <https://www.edx.org>
4. <https://www.mygreatlearning.com/academy>
5. <https://www.simplilearn.com>

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

- | | |
|---|---|
| <ul style="list-style-type: none"> ● Lectures/ Guest Lectures ● Visits (Social/Field) and reports ● Demonstrations | <ul style="list-style-type: none"> ● Surveys ● Mini-Project ● Hands on experience on focused topic |
|---|---|

A report of 15-20 pages contains any of the activity details mentioned above.

Semester VIII

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417530: Computational Intelligence

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
---	----------------------------	---

Prerequisites Courses: Artificial Neural Network (317531), Artificial Intelligence (310253)

Companion Course: Computer Laboratory III (417533)

Course Objectives:

- To provide students with a comprehensive understanding of the fundamental concepts, theories, and techniques in the field of computational intelligence
- To understand, explain, and apply the fuzzy set and fuzzy logic in real life applications
- To familiarize with various evolutionary algorithms and optimization techniques inspired by natural evolution processes
- To understand the principles, techniques, and applications of genetic algorithms
- To apply computational intelligence techniques to solve complex NLP problems
- To introduce the concepts inspired by the human immune system and their application in problem-solving and optimization

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Understand Computational Intelligence techniques to solve real-life problems

CO2: Apply fuzzy logic techniques to solve real life problems

CO3: Design and implement evolutionary algorithms to solve optimization problem

CO4: Analyze and evaluate the performance of genetic algorithms in terms of convergence and computational efficiency

CO5: Interpret and analyze the results obtained from computational intelligence models in NLP, providing meaningful insights and recommendations

CO6: Design and Develop Artificial Immune System to solve complex problems

Course Contents

Unit I	Introduction To Computational Intelligence	06 Hours
Introduction to Computational Intelligence, Paradigms of Computational Intelligence, Difference between Artificial Intelligence and Computational Intelligence, Approaches to Computational Intelligence, Synergies of Computational Intelligence Techniques, Applications of Computational Intelligence, Grand Challenges of Computational Intelligence		
#Exemplar/Case Studies	Study of Intelligent Waste Classification System using Computational Intelligence	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Fuzzy Logic	06 Hours
Introduction to Fuzzy Set- Introduction, definition, membership Function, Fuzzy operator, Fuzzy Set Characteristics, Fuzziness and Probability.		
Fuzzy Logic and Reasoning -Fuzzy Logic: Linguistics Variables and Hedges, Fuzzy Rules. Fuzzy Inferencing: neuro inferencing Fuzzification, Defuzzification		
Fuzzy logic Controllers: Fuzzy logic Controllers, Fuzzy logic Controller Types		

#Exemplar/Case Studies	Study of Object Detection Robot Using Fuzzy Logic Controller	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III Evolutionary Computing		06 Hours
Introduction , Evolutionary Computing, Terminologies of Evolutionary Computing, Genetic Operators, Evolutionary Algorithms: - Genetic Algorithm, Evolution Strategies, Evolutionary Programming, Genetic Programming, Performance Measures of EA, Evolutionary Computation versus Classical Optimization.		
Advanced Topics: Constraint Handling, Multi-objective Optimization, Dynamic Environments Swarm Intelligence: Ant Colony Optimization		
#Exemplar/Case Studies	Study of Engineering application of Artificial humming bird algorithm	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV Genetic Algorithm		06 Hours
Introduction to Basic Terminologies in Genetic Algorithm: Individuals, Population, Search space, Genes, Fitness function, Chromosome, Trait, Allele, Genotype and Phenotype. GA Requirements and representation- Binary Representations, Floating-Point Representations Operators in Genetic Algorithm: Initialization, Selection, Crossover (Recombination), Mutation; fitness score, Stopping Condition, reproduction for GA Flow, Constraints in Genetic Algorithms. Genetic Algorithm Variants: Canonical Genetic Algorithm (Holland Classifier System), Messy Genetic Algorithms, Applications, and benefits of Genetic Algorithms.		
#Exemplar/Case Studies	Use Genetic Algorithm to design a solution to the Traveling Salesman Problem. Solution: 1. Use Permutation Encoding 2. DefineObjective Function. 3. Apply Selection Method 4. Crossover 5. Mutation 6. Repeat Until stopping criteria is met. 7.Stop	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V Computational Intelligence and NLP		06 Hours
Introduction, Word embedding Techniques-Bag of Words, TF-IDF, Word2Vec, Glove, Neural word embedding, Neural Machine Translation, Seq2Seq and Neural Machine Translation, translation Metrics (BLEU Score & BERT Score) , Traditional Versus Neural Metrics for Machine Translation Evaluation, Neural Style Transfer, Pertained NLP BERT Model and its application		
#Exemplar/Case Studies	1) Study of Patient Triage using ChatGPT which can be utilized by physicians for expedited diagnoses. 2) Study of Question Answering System with BERT	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI Artificial Immune Systems		06 Hours
Natural Immune System, Artificial Immune Models, Artificial Immune System Algorithm, Classical View Models, Clonal Selection Theory Model, Network Theory Model, Danger Theory Model, Dendritic cell Model, Applications of AIS models		
#Exemplar/Case Studies	Study of an artificial immune system with bootstrap sampling for the diagnosis of recurrent endometrial cancers	

*Mapping of Course Outcomes for Unit VI	CO6																								
	Learning Resources																								
Text Books:																									
<ol style="list-style-type: none"> 1. Andreis P. Engelbrecht, “Computational Intelligence an introduction”, 2nd edition, Wiley publication 2. Nazmul Siddique, Hojjat Adeli, “Computational Intelligence, Synergies of Fuzzy logic, Neural Networks and Evolutionary computing”, Wiley publication 3. S. Rajasekaran, G. A. Vijayalakshmi, “Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications”, PHI, 2007 																									
Reference Books:																									
<ol style="list-style-type: none"> 1. Seyedali Mirjalili, “Evolutionary Algorithms and Neural Networks Theory and Applications, Studies in Computational Intelligence”, Vol 780, Springer, 2019, 2. Sitendra Tamrakar, Shruti Bhargava Choubey, Abhishek Choubey, “Computational Intelligence in Medical Decision Making and Diagnosis Techniques and Applications”, CRC Press, 2023 3. Melanie Mitchell, “An Introduction to Genetic Algorithms,” MIT Press, 2000 4. James M. Keller, Derong Liu, David B. Fogel, “Fundamentals of Computational Intelligence: Neural Networks, Fuzzy Systems, and Evolutionary Computation”, John Wiley & Sons, 2016 5. Sudharsan Ravichandiran, “Getting Started with Google BERT, Build and train state-of-the-art natural language processing models using BERT”, Packt Publishing, 2021, ISBN 9781838826239 6. Mitchell Melanie, “An Introduction to Genetic Algorithms”, The MIT Press Cambridge, Massachusetts, MIT Press paperback edition, 1998 7. Xin-She Yang, “Nature-Inspired Metaheuristic Algorithms”, 2nd edition, University of Cambridge, United KingdomLuniver Press 																									
MOOC Courses:																									
<ol style="list-style-type: none"> 1. Fuzzy Sets, Logic and Systems & Applications, IIT Kanpur: https://nptel.ac.in/courses/108104157 2. Fuzzy Logic and Neural Networks: https://youtu.be/xwUKQcT1bKc 3. Evolutionary Computation for Single and Multi-Objective Optimization: https://onlinecourses.nptel.ac.in/noc21_me43/preview 4. Traditional and Non-Traditional Optimization Tools, IIT Kharagpur: https://nptel.ac.in/courses/112105235 5. Introduction to Soft Computing, IIT Kharagpur: https://nptel.ac.in/courses/106105173 6. Applied Natural Language Processing, Chennai Mathematical Institute: https://nptel.ac.in/courses/106106211 																									
The CO-PO Mapping Matrix																									
CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12													
CO1	3	2	1	2	-	-	-	-	-	-	-	-													
CO2	3	2	2	2	1	-	-	-	-	-	-	-													
CO3	2	2	3	2	-	-	-	-	-	-	-	-													
CO4	2	3	3	2	-	-	-	-	-	-	-	-													
CO5	2	2	2	2	1	1	-	-	-	1	-	1													
CO6	2	2	3	2	1	1	-	-	-	-	-	1													

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417531: Distributed Computing

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
--	----------------------------	---

Prerequisites Courses: Computer Network (317521), Data Science (317529)

Companion Course: Computer Laboratory III (417533)

Course Objectives:

- To understand the fundamentals and knowledge of the architectures of distributed systems
- To gain knowledge of working components and fault tolerance of distributed systems
- To make students aware about security issues and protection mechanisms for distributed environments

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Understand the features and properties of Distributed computing system with integration of AI

CO2: Analyze the Concept of data management and storage in distributed computing

CO3: Understand the algorithm used in distributed computing by applying artificial intelligence

CO4: Understand the integration of machine learning algorithm and advanced tools used in distributed computing

CO5: Analyze how big data is processed in distributed computing

CO6: Identify Security and privacy issues of distributed computing and apply on specific application

Course Contents

Unit I	Introduction to Distributed Computing	06 Hours
Fundamentals of distributed computing: Characteristics of Distributed Systems: Issues, Goals, and Types of distributed systems, Distributed System Models		
Introduction to Artificial Intelligence and Data Science in distributed computing: Distributing computational tasks, handling large volumes of data, and leveraging parallel processing capabilities, issues related to data storage and retrieval, data consistency, communication overhead, synchronization, and fault tolerance.		
Use cases and applications of integrating AI and data science in distributed systems: Predictive Maintenance, Fraud Detection, Intelligent Transportation Systems, Supply Chain Optimization, Energy Management, Healthcare and Medical Diagnostics, Customer Behavior Analysis and Natural Language Processing (NLP)		
#Exemplar/Case Studies	Introduction to Distributed Computing in E-commerce	
*Mapping of Course	CO1	
Outcomes for Unit I		
Unit II	Distributed Data Management and Storage	06 Hours

Overview of Distributed Computing Frameworks and Technologies

Parallel Computing, Distributed Computing Models, Message Passing, Distributed File Systems: Hadoop Distributed File System (HDFS) and Google File System (GFS), Cluster Computing: (AWS), Microsoft Azure, and Google Cloud Platform (GCP), Message Brokers and Stream Processing, Edge Computing

Data Replication and Consistency Model: Eager Replication, Lazy Replication, Quorum-Based Replication, Consensus-Based Replication, Selective Replication, Strong Consistency, Eventual Consistency, Read-your-writes Consistency, Consistent Prefix Consistency, Causal Consistency

Distributed data indexing and retrieval techniques: Distributed Hash Tables (DHTs), Distributed Inverted Indexing, Range-based Partitioning, Content-based Indexing, Peer-to-Peer (P2P) Indexing, Hybrid Approaches

#Exemplar/Case Studies	Distributed Data Management and Storage in Healthcare
*Mapping of Course Outcomes for Unit II	CO2

Unit III | Distributed Computing Algorithms | 06 Hours

Distributed Computing Algorithms: Communication and coordination in distributed systems
Distributed consensus algorithms (Other consensus algorithms • Viewstamped Replication • RAFT • ZAB • Mencius • Many variants of Paxos (Fast Paxos, Egalitarian Paxos etc))

Fault tolerance and recovery in distributed systems,

Load balancing and resource allocation strategies: Weighted Round Robin, Least Connection, Randomized Load Balancing, Dynamic Load Balancing, Centralized Load Balancing, Distributed Load Balancing, Predictive Load Balancing

Applying AI techniques to optimize distributed computing algorithms: Machine Learning for Resource Allocation, Reinforcement Learning for Dynamic Load Balancing, Genetic Algorithms for Task Scheduling, Swarm Intelligence for Distributed Optimization

#Exemplar/Case Studies	Distributed Computing Algorithms in Weather Prediction
*Mapping of Course Outcomes for Unit III	CO3

Unit IV | Distributed Machine Learning and AI | 06 Hours

Introduction to distributed machine learning algorithms: Types of Distributed Machine Learning: Data Parallelism and Model Parallelism, Distributed Gradient Descent, Federated Learning, All-Reduce, Hogwild, Elastic Averaging SGD

Software to implement Distributed ML: Spark, GraphLab, Google TensorFlow, Parallel ML System (Formerly Petuum), Systems and Architectures for Distributed Machine Learning

Integration of AI algorithms in distributed systems: Intelligent Resource Management, Anomaly Detection and Fault Tolerance, Predictive Analytics, Intelligent Task Offloading

#Exemplar/Case Studies	Distributed Machine Learning and AI in Fraud Detection
*Mapping of Course Outcomes for Unit IV	CO4

Unit V | Big Data Processing in Distributed Systems | 06 Hours

Big data processing frameworks in distributed computing: Hadoop, Apache Spark, Apache Storm, Samza, Flink

Parallel and distributed data processing techniques: Single Instruction Single Data (SISD), Multiple Instruction Single Data (MISD), Single Instruction Multiple Data (SIMD), Multiple Instruction Multiple Data (MIMD), Single program multiple data (SPMD), Massively parallel processing (MPP)

Scalable data ingestion: types of data ingestion, Benefits, challenges, tools, transformation in distributed systems

Real-time analytics and Streaming analytics: types of real time analytics, types of streaming analytics, Comparison of real time analytics and streaming analytics, Applying AI and data science for large-scale data processing and analytics.

#Exemplar/Case Studies	Big Data Processing in Distributed Systems for Social Media Analytics
*Mapping of Course Outcomes for Unit V	CO5
Unit VI	Distributed Systems Security and Privacy

06 Hours

Security Challenges in Distributed Systems, Insider Threats, Encryption and Secure Communication: TLS/SSL, PKI, VPN, AMQP, Privacy Preservation Techniques: Differential Privacy, Homomorphic Encryption, Secure Multi-Party Computation (SMPC), Federated Learning, Anonymization and Pseudonymization, Access Control and Data Minimization, AI-based Intrusion Detection and Threat Mitigation Techniques: Anomaly Detection, Behavior-based Detection, Threat Intelligence and Analysis, Real-time Response and Mitigation, Adaptive Security, User and Entity Behavior Analytics (UEBA), Threat Hunting and Visualization.

#Exemplar/Case Studies	Distributed Systems Security and Privacy in Healthcare
*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. Sigeru Omatsu, Qutaibah M. Malluhi, Sara Rodríguez Gonzalez, Grzegorz Bocewicz, Edgardo Bucciarelli, Gianfranco Giulioni, Farkhund Iqba, “Distributed Computing and Artificial Intelligence”, 12th International Conference: 373 (Advances in Intelligent Systems and Computing) Paperback
2. George Coulouris, J Dollimore and Tim Kindberg, “Distributed Systems, Concepts and Design”, Pearson Education, 5th edition
3. Andrew S.Tanenbaum, Maarten Van Steen, “Distributed Systems, Principles and paradigms”, 2nd edition, PHI
4. Michael Huhns, “Distributed Artificial Intelligence” Volume I 1st edition, 1987

Reference Books:

1. Pradeep K. Sinha, “Distributed Operating System”, PHI
2. Tanenbaum S., “Distributed Operating Systems”, Pearson Education
3. Sikumar Ghosh, “Distributed Systems, An Algorithm Approach”, Chapman & Hall/CRC, Taylor & Francis Group, 2007.
4. Ajay D. Kshemkalyani, Mukesh Singhal, “Distributed Computing: Principles, Algorithms, and Systems”

MOOC Courses:

1. NPTEL: <https://archive.nptel.ac.in/courses/106/106/106106168/>
2. Distributed Computing with Spark SQL | Coursera
3. Distributed Systems for Practitioners | Educative

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective V 417532(A): Virtual Reality and Game Development

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
--	----------------------------	---

Prerequisites Courses: Data Science (317529), Artificial Neural Network (317531)

Companion Course: Computer Laboratory IV (417534)

Course Objectives:

- To introduce the fundamentals of Virtual Reality
- To understand VR systems and development tools
- To acquaint with the tools like blender, unreal which are required to develop virtual reality concept
- To understand the game development process with content creation strategies and production techniques
- To enable students to continue their studies in the areas of virtual reality, gaming and artificial intelligence

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Review the basics of virtual reality and its applications

CO2: Explore the many levels at which the user interacts with a virtual world using the medium of virtual reality

CO3: Recognize the human aspects in Virtual Reality & it's tools

CO4: Design a game prototype

CO5: Utilize Blender's modeling tools to create and manipulate the objects

CO6: Describe about the methods used in VR and AI game development

Course Contents

Unit I	Introduction	06 Hours
---------------	---------------------	-----------------

Introduction to virtual reality- Definition of VR, modern experiences, historical perspective

Human psychology and Perception. How virtual reality really works

Geometry of virtual worlds: -Geometric modeling, transforming rigid bodies, yaw, pitch, roll, axis-angle representation, quaternions

Virtual Reality: -Applications, Limitations, Challenges

#Exemplar/Case Studies

***Mapping of Course**

Outcomes for Unit I

Unit II	Virtual reality system	06 Hours
----------------	-------------------------------	-----------------

Input Devices: - Trackers, Navigation, and gesture interface,

Output Devices: -Graphics, three - dimensional sound and haptic display, CAVE and HMD VR systems
Rendering the Virtual World - Rendering systems - Interaction, Graphical rendering, ray tracing, shading

Motion in Real and Virtual Worlds: -Velocities, acceleration, vestibular system, virtual world physics, collision detection, avatar motion

#Exemplar/Case Studies	Oculus Quest - All in one device	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III Human Factors in VR & Tools		06 Hours
Human factors: Introduction, the eye, the ear, the somatic senses, human Vision, Methodology and Terminology: Data Collection and Analysis, Usability Engineering Methodology.		
Human Factors in VR Evaluations: Testbed Evaluation of Universal VR Tasks, Influence of System Responsiveness on User Performance, Influence of Feedback Multimodality, VR Health, and Safety Issues, Direct Effects of VR Simulations on User, VR in social aspects		
VR Tools: Introduction to Unity, Blender, MAYA, Amazon Sumerian, Google VR, 3ds Max, Unreal		
#Exemplar/Case Studies	Study of Unity tools	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV Game Design & Prototyping		08 Hours
Introduction to gaming: History of Video games, Gaming Platforms and Player Modes, Ludology, Common Frameworks for Ludology – MDA; Formal, Dramatic, and Dynamic Elements; Elemental Tetrad, Designer centric & Player centric design goals, Game Genres, Player motivations		
Story & Character development, Guiding the Player, Creating gaming experience Level Design: Structure, Time, Space Game Testing: Why Playtest? Circles of Play testers, Methods of Playtesting		
#Exemplar/Case Studies	Study of Puzzle Design and Puzzle Examples in Action Games	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V Gaming VR with Blender		08 Hours
Introduction to Blender's interface and Modelling: Selecting, transforming, and adjusting the objects in 2D, Texturing and Shading 2D images in Blender, performing object modifiers, Working with blend files		
Performing 3D Animation on blender: - Introduction to 3D modelling basics, 3d View in Blender, The Concept of Timeline and Keyframes		
#Exemplar/Case Studies	Prepare a case study on how VR is helping to solve the challenges in construction site. Write a case study on how to understand the working of computer using VR.	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI VR & AI in Gaming		06 Hours
VR in game: -Features of VR game, Problems with VR game, Impact of artificial intelligence on VR game,		
Introduction to AI in Game: - Game AI Model, Solving problems by searching algorithms heuristic & non heuristic methods, optimal path finding using AI		
#Exemplar/Case Studies	Navigation Mesh & Path finding game	

*Mapping of Course Outcomes for Unit VI	CO6											
	Learning Resources											
Text Books:												
<ol style="list-style-type: none"> 1. Burdea, G. C., P. Coffet., "Virtual Reality Technology", 2nd edition, Wiley-IEEE Press, 2006 2. Jeannie Novak, "Game Development Essentials", 3rd edition, Cengage Learning 3. James Chronister, "Blender Basics Classroom Tutorial Book", 5th edition 												
Reference Books:												
<ol style="list-style-type: none"> 1. Jeremy Gibson Bond, "Introduction to Game Design, Prototyping, and Development - From Concept to Playable Game with Unity and C#", 2nd edition, Pearson Publication 2. Jesse Schell, "The Art of Game Designing - A Book of Lenses", Morgan Kaufmann Publishers 3. Lance Flavell, "Beginning Blender: Open Source 3D Modeling, Animation, and Game Design" 4. Steven M. LaValle, "Virtual Reality", Cambridge University Press, 2016 5. Millington, Ian, "Artificial Intelligence for Games", 3rd edition, CRC Press, 2019 6. Stuart J. Russell, Peter Norvig, "Artificial Intelligence A Modern Approach", Pearson, Education, 2003 												
e-Resources:												
<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/106/106/106106138/ 2. https://www.coursera.org/learn/introduction-virtual-reality 3. https://www.udemy.com/course/virtual-reality-game-development/ 4. https://docs.idew.org/video-game/ 5. https://gamecodeschool.com/essentials-tutorials/ 6. https://github.com/Kavex/GameDev-Resources 7. https://www.blender.org/support/tutorials/ 												
MOOC Courses:												
<ol style="list-style-type: none"> 1. Introduction to Game Development: https://www.codecademy.com/learn/introduction-to-game-development 2. Introduction to Game Design: https://www.coursera.org/learn/game-design 3. Certificate Course in Augmented & Virtual Reality: https://futureskillsp prime.in/course/certificate-course-in-augmented-%26-virtual-reality 												
The CO-PO Mapping Matrix												
CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1	-	1	-	-	-	-	-	2
CO2	3	1	-	-	1	-	-	-	-	-	-	2
CO3	3	3	3	2	3	3	-	2	-	-	-	2
CO4	3	3	3	2	-	-	-	-	-	-	-	2
CO5	3	2	3	1	3	-	-	-	-	-	-	3
CO6	3	2	3	2	-	-	-	-	-	-	-	2

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective V 417532(B): Big Data Analytics

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
--	----------------------------	---

Prerequisites Courses: Artificial Intelligence (310253), Data Science (317529)

Companion Course: Computer Laboratory IV (417534)

Course Objectives:

- To introduce students to basic concepts, terms, applications of big data
- To apprehend Advanced Analytical Methods in Data Science
- To acquaint with the tools like Hadoop, NoSQL, MapReduce which are required to manage and analyze big data
- To program various issues related to Industry standards using Big Data Analytics
- To visualize Big Data using different tools

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Apply the techniques to handle missing data for real world applications.

CO2: Exemplify Analytical Methods like Clustering and Association Rule for Big Data Analytics

CO3: Use the novel architectures and platforms introduced for Big data, in particular Hadoop and Map Reduce

CO4: Differentiate the advanced predictive analytics algorithms in various applications like Retail, Finance, Healthcare

CO5: Evaluate needs, challenges, and techniques for big data visualization

CO6: Design various applications and simulate the analytics tools

Course Contents

Unit I	Unit Introduction to Big Data and Analytics	06 Hours
Introduction to Big Data: Characteristics – Evolution – Definition - Challenges with Big Data, Traditional Business Intelligence versus Big Data. State of Practice in Analytics, Key roles for New Big Data Ecosystems.		
Big Data Analytics:	Introduction & importance of Analytics, Classification of Analytics – Challenges - Big Data Analytics, Big Data Technologies (Apache Hadoop, Rapid miner, Looker), Soft state eventual consistency.	
#Exemplar/Case Studies	Study on big data business models like Walmart, Netflix, Uber	
*Mapping of Course	CO1, CO3	
Outcomes for Unit I		
Unit II	Basic Data Analytic Methods	06 Hours
Need of Big Data Analytics		
Advanced Analytical Theory and Methods:		
Clustering- Overview, K means- Use cases, Overview of methods, determining number of clusters, diagnostics, reasons to choose and cautions.		
Association Rules- Overview, a-priori algorithm, evaluation of candidate rules, case study- transactions in grocery store, validation and testing, diagnostics.		
Regression- linear, logistics, reasons to choose and cautions, additional regression models.		

#Exemplar/Case Studies	K means clustering- Food Delivery Case Study/Customer Data Segmentation Association Rule - Super Market Analysis	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III Predictive Analysis Process and R		06 Hours
Introduction to R: R graphical User Interfaces, Data import and Export, Dirty Data, Data Analysis, Linear regression with R, clustering with R hypothesis testing, Data cleaning and validation tools: MapReduce Data Analytics Lifecycle: Discovery, Data Preparation, Model Planning, Model Building, communicate results, Operationalize, Building a Predictive model.		
#Exemplar/Case Studies	Case study on how data analytics stacks work and the factors influencing their performance	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV Advanced Predictive Analytics Algorithms and Python		06 Hours
Introduction of Exploratory Data Analytics (EDA) -Definition, Motivation, Steps in data exploration, data types. Techniques to Improve Classification Accuracy: Introducing Ensemble Methods, Bagging, Boosting and AdaBoost, Random Forest. Model Evaluation and Selection - Confusion Matrix, Dataset Partitioning Methods-Holdout Method and Random Subsampling, Cross Validation.		
#Exemplar/Case Studies	Case Study on Big Data Analytics in Healthcare Domain - How Big Data is transforming the healthcare industry?	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V Big Data Visualization		06 Hours
Introduction to Data Visualization: Objective and challenges to Big data visualization, Conventional data visualization tools, techniques for visual data representation, types of data visualization, Tools used in data visualization, Open – source data visualization tools, Analytical techniques used in Big data visualization, Data Visualization using Tableau Introduction to: Candela, D3.js, Google Chart API		
#Exemplar/Case Studies	Analysis of a business problem of online delivery system using visualization	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI Big Data Analytics Applications and Tools		06 Hours
Big Data Analytics Applications: Retail Analytics, Financial Data Analytics, Healthcare Analytics, Supply chain management Types of Big Data Analytics tools: Data Collection Tools-Semantria tool, AS Sentiment Analysis tool, Data Storage tools and frameworks: Apache HBase, CouchDB, Data filtering and extraction tool: Scraper, Mozenda, Comparison of Various Tools		
#Exemplar/Case Studies	Customer Case Study using Big Data Analytics Tool	

*Mapping of Course Outcomes for Unit VI	CO6
--	-----

Learning Resources**Text Books:**

1. Wiley CIO, Michael Minelli, Michele Chambers, Ambiga Dhiraj, John Wiley & Sons, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", 2012
2. EMC Education Services, "Data Science and Big Data Analytics-Discovering, analyzing Visualizing and Presenting Data", 1st edition
3. Han, Jiawei Kamber, Micheline Pei and Jian, "Data Mining: Concepts and Techniques", Elsevier Publishers, ISBN:9780123814791, 9780123814807

Reference Books:

1. Manovich, Lev., "Trending: The Promises and the Challenges of Big Social Data. Debates in the Digital Humanities", The University of Minnesota Press, 2012
2. Raj, Pethuru, "Handbook of Research on Cloud Infrastructures for Big Data Analytics", IGI Global, 2014
3. Wajid Khattak, Paul Buhler, Thomas Erl, "Big Data Fundamentals: Concepts, Drivers & Techniques", John Wiley & Sons, ISBN: 13: 9780134291079

e-Resources:

1. <https://files.eric.ed.gov/fulltext/ED536788.pdf>
2. <https://www.iare.ac.in/sites/default/files/NEW%20LECHURE%20NOTES.pdf>
3. [https://mrcet.com/downloads/digital_notes/CSE/IV%20Year/\(R17A0528%20\)%20Big%20Data%20Analytics%20Digital%20notes.pdf](https://mrcet.com/downloads/digital_notes/CSE/IV%20Year/(R17A0528%20)%20Big%20Data%20Analytics%20Digital%20notes.pdf)
4. <https://content.e-bookshelf.de/media/reading/L-11307411-11b3dd5f67.pdf>

MOOC Courses:

1. Big Data Computing: https://onlinecourses.nptel.ac.in/noc20_cs92/preview
2. Applied Optimization For Wireless, Machine Learning, Big Data: https://onlinecourses.nptel.ac.in/noc23_ee99/preview
3. Big Data Computing by NPTEL: <https://www.shiksha.com/online-courses/big-data-computing-by-nptel-course-nptel33>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective V 417532(C): Software Development for Portable Devices

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
--	---------------------	---

Prerequisites Courses: Object Oriented Programming, Computer Network

Companion Course: Computer Laboratory IV (417534)

Course Objectives:

- To introduce the fundamentals of software development for portable devices
- To understand android application architecture, its components, device discovery and communication in portable devices
- To acquaint with the use of various hardware sensors (location etc.) and software services (e.g., notifications) on android devices
- To understand the GoogleFit platform for portable devices
- To enable students to continue their studies in the real-world application and future use of portable devices

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Differentiate types of portable devices and sensor fundamentals

CO2: Design and develop a software application for device discovery and communication in portable devices

CO3: Design and develop application using different sensors and services on portable devices

CO4: Design applications in Android wear OS

CO5: Utilize application development GoogleFit platform for portable devices and Database

CO6: Identify the role of portable devices in real world application

Course Contents

Unit I	Introduction	06 Hours
Introduction: Introduction to software development for portable devices, types of Portable Devices, hardware & software for Portable Devices, Applications of Portable Devices, Sensor Fundamentals: Types of sensors (Motion, Position, Environmental), Components of the sensor framework, applications of sensors, Features of Portable Devices, Mobile App development Challenges, Android tooling support		
#Exemplar/Case Studies	Study of different sensors with their applications	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Android Device Discovery and Communication	06 Hours

Android: An Open Platform for Mobile Development, Android SDK Features, Android Software Stack, Android Application Architecture, Types of Android Applications, Android development tools.

Creating Applications and Activities: Manifest Editor, Android Application Lifecycle, Android Creating Activities, Activity Lifecycle, Android Activity Classes, Introducing Fragment, Introducing Intents.

Android Interconnectivity: Advertisement and Discovery, Bluetooth: Remote Device Discovery, Bluetooth Communications, Wi-Fi: Monitoring Wi-Fi Connectivity, Active Wi-Fi Connection, Transferring Data Using Wi-Fi, Transferring Data Between Peers. Near Field Communication: NFC Tags, Android Beam.

#Exemplar/Case Studies	https://developer.android.com/training/cars , https://developer.android.com/training/tv/start	
	Example: Smartphone Bluetooth App to Control LED Lights	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III	MAPS Location based Services, Audio, Video and Camera	06 Hours

Using Location-Based Services: - Using Location-Based Services, Using the Emulator with Location-Based Services, Selecting a Location Provide, Using Proximity Alert ,Using the Geocoder, Example: Map-based activity

Hardware Support and Devices (AUDIO, VIDEO, AND USING THE CAMERA): -Using Sensors and the Sensor Manager, Monitoring a Device's Movement and Orientation, Introducing the Environmental Sensors, Playing Audio and Video, Using Audio Effects, Using the Camera, Recording Video

#Exemplar/Case Studies	Example: Map-based activity	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Android Wear OS	06 Hours

Android Wear platform: Android Wear OS, Wear Devices and wear API, Android notifications and android wear, (Android 5.0 Lollipop notification), Google now and Android wear.

Android Wear Devices: Android SDK Wear Platform updates, Procuring an Android Wear device, Using Android Emulator with Wear AVD, Pairing and Enabling Developer Mode, Unboxing your Wear device, Pairing your Handheld device with your Wear device

Wear Debugging and Android SDK: Wear Debugging and Android SDK via Bluetooth and USB.

Android wear API: Google Services and Google play services, Android Wear Network, Android Wear API (Node Interface, DataEvent, MessageEvent)

#Exemplar/Case Studies	https://wearos.google.com , https://developer.android.com/training/wearables	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Google Fit Platform and API, Databases and Content Providers	06 Hours

Google Fit Platform Overview; Google Fit Core Concepts: Fit Data Types, Fit Data Store (Storage), Sensors; Permissions, User Consent: Permission Groups, Fitness Scopes; Google Fit: Developer Responsibilities: Developer Terms and Conditions, Developer Branding Guidelines; Procuring Sensor Peripherals; Hello Fit: hands-on example

Google Fit API: Google fit main package, Fitness class, FitnessActivities class, FitnessStatusCodes class, BleApi interface, SensorsApi, RecordingApi, SessionsApi, HistoryApi, ConfigApi

Databases and Content Providers: Introducing Android Databases, Introducing SQLite, Content Values and Cursors, Working with SQLite Databases, Creating Content Providers, Using Content Providers

#Exemplar/Case Studies	1. The Fitness Tracker App using Google Fit API. 2. Adding Search to Your Application 3. Native Android Content Providers
-------------------------------	---

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

Unit VI	Real World Application and Future of Portable Devices	06 Hours
----------------	--	-----------------

Wearable Technology: Wearable Computer, Smartphone and Variety of wearable devices
Real world Application of Portable Devices: Handheld Application, Home Automation, Home Entertainment, Gaming, Wearable at workplace
Fitness, Health and Medical: Predictive and Proactive Consumer Health, Wearable for Medical Professional, Wearable and remote medical diagnostics
Industrial Manufacturing and Safety, Civic, Governance and Democracy

#Exemplar/Case Studies	Portable Devices: Market Estimates and Forecasts, Android Things
-------------------------------	--

*Mapping of Course Outcomes for Unit VI	CO6
--	-----

Learning Resources

Text Books:

- Varun Nagpal, "Android Sensor Programming By Example", Packt Publishing, 2016, ISBN: 978-1-78528-550-9
- Reto Meier, "Professional Android 4 Application Development", WROX Press, Wiley Publishing, 2012, ISBN: 978-1-118-10227-5
- Sanjay M. Mishra, "Wearable Android: Android Wear and Google FIT App Development", John Wiley & Sons, 2015, ISBN: 9781119050865

Reference Books:

- Rick Rogers, John Lombardo, Zigurd Mednieks, Blake Meike, SPD, "Android Application Development, Programming with the Google SDK", Orelliy, ISBN: 13:978-81-8404-733-2
- Ed Burnette, "Hello Android, Introducing Google's Mobile Development Platform", 3rd edition, Pragmatic Programmers, LLC, ISBN-10: 1-934356-56-5

MOOC Courses:

- https://www.youtube.com/watch?v=-foyVzTOf8o&list=PLJ5C_6qdAvBEJ6TBzKoa1Ov21lwDzJfM
- <https://archive.nptel.ac.in/courses/106/106/106106156/#>

The CO-PO Mapping Matrix

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
-------------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	-------------	-------------	-------------

CO1	2	2	2	1	2	-	-	-	-	-	-	-	-
CO2	2	2	3	1	2	-	-	-	-	-	2	1	
CO3	2	2	2	1	2	-	-	-	-	1	2	1	
CO4	2	2	2	1	3	-	-	-	-	1	2	1	
CO5	2	2	2	1	3	-	-	-	-	1	2	1	
CO6	2	2	2	1	1	-	-	-	-	-	-	-	3

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective V 417532(D): Deep Learning

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
---	----------------------------	---

Prerequisites Courses: Machine Learning (417521)

Companion Course: Computer Laboratory IV (417534)

Course Objectives:

- To understand the basics of neural networks
- Comparing different deep learning models
- To understand the Recurrent and Recursive nets in Deep Learning
- To understand the basics of deep reinforcement learning models
- To analyze Types of Networks
- To Describe Reinforcement Learning

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Understand the basics of Deep Learning and apply the tools to implement deep learning applications

CO2: Evaluate the performance of deep learning models

CO3: Implement the technique of Convolution neural network (CNN)

CO4: Solve the language translation problem by Recurrent neural network (RNN)

CO5: Construct new data by deep generative models

CO6: Apply on-policy reinforcement learning algorithms

Course Contents

Unit I	Foundations of Deep learning	06 Hours
What is machine learning and deep learning? History of deep learning, Advantage and challenges of deep learning. Learning representations from data , Understanding how deep learning works in three figures(input, hidden layer, output), Common Architectural Principles of Deep Network, Architecture Design, Applications of Deep learning, Hyperparameters : Learning Rate, Regularization, Momentum, Sparsity, Hidden Units, cost functions, error back propagation, Gradient-Based Learning, Implementing Gradient Descent, vanishing and Exploding gradient descent, Optimization algorithm(SGD, AdaGrad, RMSProp, adam).		
#Exemplar/Case Studies	Deep Mind, AlphaGo, Boston Dynamics, Amazon go store	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Deep Neural Networks (DNNs)	06 Hours
Introduction to Neural Networks :The Biological Neuron, The Perceptron(AND,OR,NOT,XOR), Deep forward network, Multilayer Feed-Forward Networks , Training Neural Networks :Backpropagation and Forward propagation Activation Functions :Linear ,Sigmoid, Tanh, Hard Tanh, Softmax, Rectified Linear, Loss Functions :Loss Function Notation , Loss Functions for Regression , Loss Functions for Classification, Loss Functions for Reconstruction.		
#Exemplar/Case Studies	A Case Study for Music Genre Classification	

*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Convolution Neural Network (CNN)	06 Hours
Introduction, CNN architecture overview, The Basic Structure of a Convolutional Network- Padding, Strides, Typical Settings, the ReLU layer, Pooling, Fully Connected Layers, The Interleaving between Layers, Local Response Normalization, Training a Convolutional Network		
#Exemplar/Case Studies	AlexNet, VGG	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Recurrent Neural Network (RNN)	06 Hours
Recurrent and Recursive Nets: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Echo State Networks, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs, Optimization for Long-Term Dependencies, Explicit Memory. Practical Methodology: Performance Metrics, Default Baseline Models, Determining Whether to Gather More Data, Selecting Hyper parameters.		
#Exemplar/Case Studies	Multi-Digit Number Recognition, Google, bing, DuckDuckGo	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Deep Generative Models	08 Hours
Introduction to deep generative model, Boltzmann Machine, Deep Belief Networks, Generative adversarial network (GAN), discriminator network, generator network, types of GAN, Applications of GAN networks		
#Exemplar/Case Studies	GAN for detection of real or fake images, chatGPT	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Reinforcement Learning	06 Hours
Introduction of deep reinforcement learning, Markov Decision Process, basic framework of reinforcement learning, challenges of reinforcement learning, Dynamic programming algorithms for reinforcement learning, Q Learning and Deep Q-Networks, Deep Q recurrent networks, Simple reinforcement learning for Tic-Tac-Toe.		
#Exemplar/Case Studies	Self driving cars, Deep learning for chatbots	
*Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		

Text Books:

1. Goodfellow, I., Bengio, Y., Courville, A, “Deep Learning”, MIT Press, 2016
2. Josh Patterson & Adam Gibson, “Deep Learning”
3. Charu Agarwal, “Neural Networks and deep learning”
4. Nikhil Buduma, “Fundamentals of Deep Learning”, SPD
5. Francois chollet, “Deep Learning with Python”

Reference Books:

1. Richard S. Sutton and Andrew G. Barto, “Reinforcement Learning: An Introduction”
2. SethWeidman, “Deep Learning from Scratch: Building with Python from First Principles” O'Reilly
3. Francois Duval, “Deep Learning for Beginners, Practical Guide with Python and Tensorflow”

e-Resources:

1. <http://csis.pace.edu/ctappert/cs855-18fall/DeepLearningPractitionersApproach.pdf>
2. https://www.dkriesel.com/_media/science/neuronalenetze-en-zeta2-1col-dkrieselcom.pdf

MOOC Courses:

1. Deep Learning- Part 1, IIT Madras: <https://nptel.ac.in/courses/106106184>
2. Deep Learning Specialization: <https://www.coursera.org/specializations/deep-learning>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective VI 417533(A): Augmented Reality

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
---	----------------------------	---

Prerequisites Courses: Programming and Problem-Solving, Artificial Intelligence & Machine Learning

Companion Course: Computer Laboratory IV (417534)

Course Objectives:

- To introduce the importance of augmented reality and its need
- To create awareness of augmented reality and its application for society
- Visual Perception is used to develop the future of Business and Industry

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Understand the working of AR systems and list the applications of AR

CO2: Understand and analyze the hardware requirement of AR

CO3: Use computer vision concepts for AR and describe AR techniques

CO4: Analyze and understand the working of various state-of-the-art AR devices

CO5: Identify the working of various AR components and AR devices

CO6: Prediction of AR business applications

Course Contents

Unit I	Introduction to Augmented Reality	06 Hours
Introduction to Augmented Reality: Defining augmented reality, history of augmented reality, Augmented reality as an emerging technology, The Relationship between Augmented Reality and Other Technologies-Media, Technologies, Comparative study of AR, VR, and Mixed Reality, Other Ideas Related to the Spectrum between Real and Virtual Worlds, applications of Augmented reality, Augmented Reality Concepts- Working of Augmented Reality? Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.		
#Exemplar/Case Studies	Augmented Reality simulation system application in a Healthcare	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Component & Hardware Device in Augmented Reality	06 Hours
Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, and Sensor Fusion. Types of AR devices.		
#Exemplar/Case Studies	Study the design of an AR application with C# and Unity	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Computer Vision and Augmented Reality	06 Hours

Computer Vision for Augmented Reality -Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, and Outdoor Tracking.

Augmented Reality Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.

#Exemplar/Case Studies	Study all the available AR toolkits.
*Mapping of Course Outcomes for Unit III	CO3

Unit IV	Augmented Reality Techniques	06 Hours
Augmented Reality Techniques - Marker-based, Marker-less, Location-based, types of markers, marker camera pose, and identification, visual tracking, mathematical representation of matrix multiplication		
Marker-Based AR Example , Marker types- Template markers, 2D barcode markers, imperceptible markers		
Marker-less approach - Localization-based augmentation, real-world examples		
Tracking methods - Visual tracking, feature-based tracking, hybrid tracking, initialization and recovery, Augmented Reality System, Threats of Augmented Reality		

#Exemplar/Case Studies	Study on enhancement and improving markers with Vuforia engine
*Mapping of Course Outcomes for Unit IV	CO4

Unit V	Augmented Reality Components and Devices	06 Hours
Augmented Reality Components – Scene Generator, Tracking system, monitoring system, display, and Game scene		
AR Devices – Optical See-Through HMD, Virtual retinal systems, monitor bases systems, Projection displays, Video see-through systems		
#Exemplar/Case Studies		

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

Unit VI	Unit Augmented Reality Tools and its Applications	06 Hours
Tools available for Augmented Reality and Recognition , Software Tools, Google Poly, Unity, software approaches, recognition types, and native software solutions		
ARKit, ARCore – software development kit - Cloud services		
AR business applications – weather prediction, market prediction, smart cities		
AR application for the healthcare sector, Education, Agriculture, Civil Engineering, Architecture, Archaeology, Crime and Security, Games, and IoT		
#Exemplar/Case Studies		
*Mapping of Course Outcomes for Unit VI		

Learning Resources

Text Books:

1. Allan Fowler, “AR Game Development”, 1st edition, A press Publications, 2018, ISBN: 978-1484236178
2. Schmalstieg / Hollerer, “Augmented Reality: Principles & Practice”, 1st edition, Pearson Education India, 2016, ISBN: 10: 9332578494

Reference Books:

1. Kharis O'Connell, ‘Designing for Mixed Reality’, O'Reilly Media, Inc., 2016, ISBN: 9781491962381
2. Sanni Siltanen, “Theory and applications of marker-based augmented reality” Julkaisija – Utgivare Publisher, 2012, ISBN: 978-951-38-7449-0

e-Resources:

1. <https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf>
2. <https://docs.microsoft.com/en-us/windows/mixed-reality/>
3. <https://docs.microsoft.com/en-us/archive/msdn-magazine/2016/november/hololens-introduction-to-the-hololens>

MOOC Courses:

1. Introduction to Augmented Reality and ARCore: <https://www.coursera.org/learn/ar>
2. Master Computer Vision™ OpenCV4 in Python with Deep Learning: <https://www.udemy.com/share/101XPi/>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective VI 417533(B): Business Intelligence

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
---	----------------------------	---

Prerequisites Courses: Database Management System (310241), Data Science (317529), Machine Learning (417521)

Companion Course: Computer Laboratory IV (417534)

Course Objectives:

- To Gain knowledge of the basic concepts of BI, principles, and components of BI, including data warehousing, data mining, analytics, and reporting
- To learn techniques for data visualization and reporting to facilitate effective decision-making
- To explain different data pre-processing techniques
- To Explore emerging trends and machine learning models in Business Intelligence
- To understand the BI Applications in various industries

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Apply conceptual knowledge on how BI is used in decision support systems

CO2: Use Modelling Concepts in Business Intelligence

CO3: Understand and apply the concept of data provisioning and data Visualization

CO4: Apply different data pre-processing techniques on data set

CO5: Implement machine learning algorithms as per business needs

CO6: Identify role of BI in Management, Inventory, Production, Logistics and Management

Course Contents

Unit I	Introduction to BI and Decision Support system	06 Hours
Business Intelligence: Definition of Business Intelligence, Brief History of Business Intelligence, Architecture & Components of Business Intelligence, Business Intelligence Scenarios, Future & Goals of Business Intelligence, Data Information & Knowledge, Business Intelligence Tasks & Analysis Formats		
Decision Support System:	Definition of Decision Support System. Information Systems Support for Decision Making, Simon's Decision Making Process, The Decision Support System-Business Intelligence Connection	
#Exemplar/Case Studies	Case study of how American Nationwide Insurance Company Used BI to Enhance Customer Service. https://www.chegg.com/homework-help/questions-and-answers/case-study-3-end-chapter-1-nationwide-insurance-used-bl-enhance-customer-service-nationwid-q86305996	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Modelling in Business Intelligence	06 Hours
Models and modelling in BI, Model Presentation, Model Building, Model Assessment and Quality of Models, Modelling using Logical Structures: ontology & Frame, Modelling using graph structure: Business process model and notation (BPMN), Modelling using probabilistic structures, Modelling using analytical structure. Model and Data: data Generation, The Role of time, Data Quality.		
#Exemplar/Case Studies	Case Study : https://link.springer.com/chapter/10.1007/978-3-642-31095-9_33	

*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Data Provisioning and Data Visualization	06 Hours
Data Provisioning: Data warehouse, schemas, Data Quality, Data profiling, Data enrichment, data duplication, ETL Architecture and what is ETL, Extraction concept and Change data capture, Transformation concept, lookups, time lag, formats, consistency, Loading concept, Initial and Incremental loading, late arriving facts, What is Staging, Data marts, Cubes.		
Data Visualization: What Is a Business Report, Components of Business Reporting Systems, Data and Information Visualization, Types of Charts and Graphs, Visual Analytics, Performance Dashboards, Business Performance Management?		
BI Tools: Tableau, power BI, Dundas BI, Oracle BI,bMs excel		
#Exemplar/Case Studies	Data Visualization Case Study: https://mschermann.github.io/data_viz_reader/case-studies.html#uber-crafting-data-driven-maps	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Data Pre-processing Techniques	06 Hours
Data validation: Incomplete data, Data affected by noise, Data transformation: Standardization, Feature extraction, Data reduction: Sampling, Feature selection, Principal component analysis, Data discretization, Data exploration: 1. Univariate analysis: Graphical analysis of categorical attributes, Graphical analysis of numerical attributes, Measures of central tendency for numerical attributes, Measures of dispersion for numerical attributes, Identification of outliers for numerical attributes. 2. Bivariate analysis: Graphical analysis, Measures of correlation for numerical attributes, Contingency tables for categorical attributes, 3. Multivariate analysis: Graphical analysis, Measures of correlation for numerical attributes		
#Exemplar/Case Studies	Case study on Data preparation phase of BI system https://blog.panoply.io/load-and-transform-how-to-prepare-your-data-for-business-intelligence	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Impact of Machine Learning in BI	06 Hours
Regression: Regression problems, Evaluation of regression models, Linear regression. Classification: Classification problems, Evaluation of classification models, Bayesian methods, Logistic regression. Clustering: Clustering methods, Partition methods, Hierarchical methods, Evaluation of clustering models. Association Rule: Structure of Association Rule, Apriori Algorithm		
#Exemplar/Case Studies	Business applications for comparing the performance of a stock over a period of time https://cleartax.in/s/stock-market-analysis	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	BI Applications, Emerging Trends and Future Impacts	06 Hours
BI Applications: Applications of Business Intelligence in Higher Education, Healthcare Monitoring, Logistics and Supply Chain Management, Customer Relationship Management, Banking Industry, Telecommunication Industry, Manufacturing Industry. Emerging Trends and Future Impacts: Location based analytics for organisations, Mobile BI, Web 2.0 and Online Social Networking, Cloud Computing and BI. Issues related to analytics.		

#Exemplar/Case Studies	Case Study : https://www.researchgate.net/publication/346664060_Emerging_trends_and_impact_of_business_intelligence_analytics_in_organizations_Case_studies_from_India
*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. Grossmann W, Rinderle-Ma, "Fundamental of Business Intelligence", Springer, ISBN: 978-662-46531-8
2. R. Sharda, D. Delen & E. Turban, "Business Intelligence and Analytics, system for Decision support", 10th edition. Pearson/Prentice Hall, 2015
3. Jiawei Han, Micheline Kamber and Jian Pei, "Data Mining Concepts and Techniques", 3rd edition", Elsevier publishers, ISBN: 9780123814791

Reference Books:

1. Paulraj Ponnian, "Data Warehousing Fundamentals", John Willey
2. "Introduction to business Intelligence and data warehousing", IBM, PHI
3. Carlo Vercellis, "Business Intelligence: Data Mining and Optimization for Decision Making", Wiley, 2019
4. "Data Mining for Business Intelligence", Wiley
5. "EMC Educational Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley, ISBN:13 978 1118876138
6. Ken W. Collier, "Agile Analytics: A value driven Approach to Business Intelligence and Data"
7. "Warehousing", Pearson Education, 2012, ISBN: 13 978 8131786826

e-Resources:

1. https://www.knime.com/sites/default/files/inline-images/KNIME_quickstart.pdf
2. www.cs.ccsu.edu/~markov/weka-tutorial.pdf
3. http://www.biomedicahelp.altervista.org/Magistrale/Clinics/BIC_PrimoAnno/IdentificazioneModelliDataMining/Business%20Intelligence%20-%20Carlo%20Vercellis.pdf
4. <https://download.e-bookshelf.de/download/0000/5791/06/L-G-0000579106-0002359656.pdf>

MOOC Courses:

1. Business Analytics for management decision: <https://nptel.ac.in/courses/110105089>
2. Business analytics and data mining modelling using R: <https://nptel.ac.in/courses/110107092>
3. Business Analysis for Engineers: <https://nptel.ac.in/courses/110106050>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective VI 417533(C): Information Systems Management

Teaching Scheme: TH: 03 Hours/Week	Cre dit0 3	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
---	-----------------------------	---

Prerequisites Courses: Operating Systems (217521), Management Information System (217530), Database Management System (310241)

Companion Course: Computer Laboratory IV (417534)

Course Objectives:

- Information Management Systems enables new approaches to improve efficiency and efficacy of business models
- To understand the role, advantages and components of an Information System
- To integrate their learning from functional areas, decision making process in an organization and role of Information Systems to have a vintage point in this competitive world

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Understand the concepts of Information systems and design the strategies

CO2: Illustrate the need of Ethical and Social Issues to Information Systems

CO3: Identify and evaluate the knowledge for Decision-Making Process

CO4: Analysis and Design of system development in project management

CO5: Apply the concept of Enterprise System Management and its Applications

CO6: Analysis how E-Commerce Business Models used in global marketplace

Course Contents

Unit I	Organizations and Information Systems	06 Hours
What Is an organization? Features of Organizations, How Information Systems Impact Organizations and Business Firms, The Fundamental Roles of IS in Business, Trends in Information Systems, Types of Information Systems, Managerial Challenges of Information Technology, The Internet and Organizations, Implications for the Design and Understanding of Information Systems, Using Information Systems to Achieve Competitive Advantage, Porter ‘s Competitive Forces Model, Information System Strategies for Dealing with Competitive Forces, The Internet ‘s Impact on Competitive Advantage.		
#Exemplar/Case Studies	eCourier, ERP	
*Mapping of Course	CO1	
Outcomes for Unit I		
Unit II	Ethical and Social Issues in Information Systems	06 Hours
Understanding Ethical and Social Issues Related to Systems, A Model for Thinking About Ethical, Social, and Political Issues, Five Moral Dimensions of the Information Age, Key Technology Trends That Raise Ethical Issues, Ethics in an Information Society, Basic Concepts: Responsibility, Accountability, and Liability, Ethical Analysis, Candidate Ethical Principles, Professional Codes of Conduct, Some Real-World Ethical Dilemmas, The Moral Dimensions of Information Systems, Information Rights, Privacy and Freedom in the Internet Age, Property Rights: Intellectual Property		
#Exemplar/Case Studies	Kiwan Code Security (SAST), Nmap, Netsparker	

*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Managing Knowledge and Enhancing Decision Making	06 Hours
The Knowledge Management Landscape, Important Dimensions of Knowledge, The Knowledge Management Value Chain, Types of Knowledge Management Systems, Enterprise-Wide Knowledge Management Systems, Enterprise Content Management Systems, Knowledge Network Systems, Collaboration And Social Tools and Learning Management Systems, Knowledge Work Systems, Knowledge Workers and Knowledge Work, Requirements of Knowledge Work Systems, Examples of Knowledge Work Systems, Decision Making and Information Systems, Business Value of Improved Decision Making, Types of Decisions, The Decision-Making Process, Managers and Decision Making in the Real World, High-Velocity Automated Decision Making, Business Intelligence in the Enterprise, What Is Business Intelligence?, The Business Intelligence Environment		
#Exemplar/Case Studies	Moneyball: Data-Driven Baseball	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Systems Development and Organizational Change Business Process Redesign	06 Hours
Overview of systems development: Systems Analysis, Systems Design, Completing the Systems Development Process, Modeling and Designing Systems: Structured and Object-Oriented Methodologies. Alternative systems-building approaches: Traditional Systems Life Cycle, Prototyping, End-User Development, Application Software Packages and Outsourcing Project management: Objectives, Management Structure for Information Systems Projects, Linking Systems Projects to the Business Plan, Information Requirements and Key Performance Indicators, Portfolio Analysis, Scoring Models, Information System Costs and Benefits, Dimensions of Project Risk. project management software tools like JIRA etc.		
#Exemplar/Case Studies	JIRA, SCRUM	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Achieving Operational Excellence and Customer Intimacy: Enterprise Applications	06 Hours
Enterprise Systems, What Are Enterprise Systems? Enterprise Software, Business Value of Enterprise Systems, Supply Chain Management Systems, The Supply Chain Information Systems and Supply Chain Management, Supply Chain Management Software, Global Supply Chains and the Internet, Business Value of Supply Chain Management Systems, Customer Relationship Management Systems, What Is Customer Relationship Management? Customer Relationship Management Software, Operational and Analytical CRM, Business Value of Customer Relationship Management Systems		
#Exemplar/Case Studies	Summit Electric Lights Up with a New ERP System	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	E-commerce: Digital Markets, Digital Goods	06 Hours

E-commerce and the Internet , E-Commerce Today, Why E-commerce Is Different, Key Concepts in E-commerce: Digital Markets and Digital Goods in a Global Marketplace E-commerce: Business and Technology, Types of E-Commerce , E-Commerce Business Models , E-Commerce Revenue Models, Social Networking and The Wisdom of Crowds, E-Commerce Marketing, B2B E-commerce: New Efficiencies and Relationships The Mobile Digital Platform and Mobile E-commerce, Location-based Services and Applications , Other Mobile Commerce Services

#Exemplar/Case Studies	To Pay or Not to Pay: Zagat's Dilemma, BHIM UPI
*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. Kenneth C. Laudon, Jane P. Laudon "Management Information Systems: Managing the Digital Firm", 13th edition, 2014, Pearson
2. James A O'Brien, George M Marakas and Ramesh Behl, "Management Information Systems", 9th edition, Tata McGraw Hill Education, New Delhi, 2009
3. James A O'Brien, George M Marakas Introduction to Information Systems, 15th edition, Tata McGraw Hill Education, New Delhi
4. Michael Hammer and James Champy, "Reengineering the Corporation: A Manifesto for Business Revolution", 1st edition, HarperCollins, 2003

Reference Books:

1. Turban, E., McLean, E. and Wetherbe, J., "Information Technology for Management: Making Connections for Strategic Advantage", 2nd edition, John Wiley and Sons, 2000
2. D.P.Goyal, "Management Information Systems-Managerial Perspectives", 2nd edition, Macmillan, New Delhi, 2006
3. S. A. Kelkar, "Management Information Systems-A concise Study", 2nd edition, Prentice Hall of India, 2009
4. Nirmalya Bagchi, "Management Information Systems", 1st edition, Vikas Publishing House, New Delhi, 2010

e-Resources:

1. David T. Bourgeois, James L. Smith Shouhong Wang, Joseph Mortati, "Information Systems for Business and Beyond"

MOOC Courses:

1. Prof. Kunal Ghosh, Prof. Surojit Mookherjee, Prof. Saini Das, IIT Kharagpur, Management Information System <https://nptel.ac.in/courses/110/105/110105148/>
2. Dr. Abhilasha Ambatipudi, Savitribai Phule Pune University, Management Information System https://onlinecourses.swayam2.ac.in/cec21_ge05/

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective VI 417533(D): Reinforcement Learning

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
---	----------------------------	---

Prerequisites Courses: Machine learning (417521)

Companion Course: Computer Laboratory IV (417534)

Course Objectives:

- To provide students with a basic understanding of RL and its connection with other related field.
- Familiarize with five main components of reinforcement learning.
- To make optimal decisions for dynamic systems using Markov decision process
- To solve real world problems using the concept of Reinforcement Learning.

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Understand RL tasks and the core principals of RL

CO2: Summarize Markov Decision Process

CO3: Model a control task in the framework of MDP

CO4: Correlate Monte Carlo Methods

CO5: Apply deep Q-network based algorithms

CO6: Solve classical control problems with tabular methods

Course Contents

Unit I	Introduction	06 Hours
Introduction and Basics of RL, Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning, Limitations and scope of RL		
#Exemplar/Case Studies	Horizon: Facebook's Open Source Applied Reinforcement Learning Platform	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Markov Decision Process	06 Hours
Markov decision processes: The Markov property, The S state set, Actions, Transition model, Rewards and Policy, The sequence of rewards assumptions : The infinite horizons, Utility of sequences, The Bellman equations, Policy iteration, Partially observable Markov decision processes : State estimation, Value iteration in POMDPs		
#Exemplar/Case Studies	Use of Markov decision process in inventory management	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Prediction and Control by Dynamic Programming	06 Hours

Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms.

#Exemplar/Case Studies	Reinforcement Learning in Autonomic Computing: A Manifesto and Case Studies			
*Mapping of Course Outcomes for Unit III	CO3			
Unit IV	Monte Carlo Methods for Model Free Prediction and Control	06 Hours		
Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Monte Carlo tree search, Importance sampling: Discounting-aware Importance Sampling, Per-decision Importance Sampling.				
#Exemplar/Case Studies	Monte Carlo for the mountain car problem in OpenAI gym			
*Mapping of Course Outcomes for Unit IV	CO4			
Unit V	Q-Learning and Deep Q-Networks	06 Hours		
Model based learning and model free learning, Temporal difference learning: On-policy and off-policy learning, Q-learning, Deep Q-networks using a convolution neural network instead of a single layer neural network, Separate target network to compute the target Q-values, Advancements in deep Q-networks and beyond: Double DQN, Dueling DQN, Q-Learning and their variants.				
#Exemplar/Case Studies	Deep Q-network for Cartpole problem in OpenAI gym			
*Mapping of Course Outcomes for Unit V	CO5			
Unit VI	Planning and Learning with Tabular Methods	06 Hours		
Models and Planning, Dyna: Integrated Planning, Acting, and Learning, When the Model Is Wrong, Prioritized Sweeping, Expected vs. Sample Updates, Trajectory Sampling, Real-time Dynamic Programming, Planning at Decision Time, Heuristic Search, Rollout Algorithms				
#Exemplar/Case Studies	Multiagent Reinforcement Learning: Rollout and Policy Iteration, IEEE/CAA Journal of Automatica Sinica (Volume: 8, Issue: 2, February 2021)			
*Mapping of Course Outcomes for Unit VI	CO6			
Learning Resources				
Text Books:				
<ol style="list-style-type: none"> 1. Reinforcement Learning with TensorFlow: A beginner's guide to designing self-learning systems with TensorFlow and OpenAI Gym, Sayon Dutta, Packt Publishing (24 April 2018) 2. Reinforcement Learning: An Introduction, second edition Richard S. Sutton and Andrew G. Barto, The MIT Press Cambridge, Massachusetts 				

Reference Books:

1. Sudharsan Ravichandiran, "Hands-On Reinforcement Learning with Python: Master Reinforcement and Deep Reinforcement Learning Using OpenAI Gym and TensorFlow"
2. Maxim Lapan, "Deep Reinforcement Learning Hands-On: Apply Modern RL Methods, with Deep Q-networks, Value Iteration, Policy Gradients, TRPO, AlphaGo Zero and More"

e-Resources:

1. Jason Gauci, "Horizon: Facebook's Open Source Applied Reinforcement Learning Platform", <https://doi.org/10.48550/arXiv.1811.00260>
2. G. Tesauro, "Reinforcement Learning in Autonomic Computing: A Manifesto and Case Studies," in IEEE Internet Computing, vol. 11, no. 1, pp. 22-30, Jan.-Feb. 2007, doi: 10.1109/MIC.2007.21
3. D. Bertsekas, "Multiagent Reinforcement Learning: Rollout and Policy Iteration," in IEEE/CAA Journal of Automatica Sinica, vol. 8, no. 2, pp. 249-272, February 2021, doi: 10.1109/JAS.2021.1003814

MOOC Courses:

1. Reinforcement Learning Specialization: <https://www.coursera.org/specializations/reinforcement-learning>
2. Reinforcement Learning Lecture Series 2021: <https://www.deepmind.com/learning-resources/reinforcement-learning-lecture-series-2021>
3. Introduction to Reinforcement Learning with David Silver: <https://www.deepmind.com/learning-resources/introduction-to-reinforcement-learning-with-david-silver>
4. Deep RL Bootcamp: <https://sites.google.com/view/deep-rl-bootcamp/lectures>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417534: Computer Laboratory III

Teaching Scheme: PR: 02 Hours/Week	Credit 01	Examination Scheme and Marks Term Work (TW): 50 Marks Practical (PR): 25 Marks
---	----------------------------	---

Prerequisites Courses: Computer Network Laboratory (317527), Software Laboratory-III (317536)

Companion Course: Computational Intelligence (417529), Distributed Computing (417530)

Course Objectives:

- To understand the fundamentals of a distributed environment in complex application
- To introduce the concepts inspired by the human immune system and their application in problem-solving and optimization
- To make students aware about security issues and protection mechanisms for distributed environments
- To familiarize with various evolutionary algorithms and optimization techniques inspired by natural evolution processes

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Apply the principles on which the internet and other distributed systems are based

CO2: Understand and apply the basic theoretical concepts and algorithms of distributed systems in problem solving

CO3: Apply fuzzy logic techniques to model and solve problems

CO4: Design and implement evolutionary algorithms to solve optimization and search problems in diverse domains

CO5: Design and implement artificial immune system algorithms to solve complex problems in different domains

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 students 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/Softcopy containing student 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 needs 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. Instructors may also set one assignment or mini-project that is suitable to the AI & DS branch beyond the scope of the syllabus.

Recommended Programming Languages: Python or Java

Suggested List of Laboratory Experiments/Assignments

Part I: Perform Any 6 assignments

1	Design a distributed application using RPC for remote computation where client submits an integer value to the server and server calculates factorial and returns the result to the client program.
2	Design a distributed application using RMI for remote computation where client submits two strings to the server and server returns the concatenation of the given strings.
3	Design a distributed application using MapReduce under Hadoop for: a) Character counting in a given text file. b) Counting no. of occurrences of every word in a given text file.
4	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relations by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.
5	Write code to simulate requests coming from clients and distribute them among the servers using the load balancing algorithms.
6	Optimization of genetic algorithm parameter in hybrid genetic algorithm-neural network modelling: Application to spray drying of coconut milk.
7	Implementation of Clonal selection algorithm using Python.
8	Create and Art with Neural style transfer on given image using deep learning.

Part II: (Perform Any 4 Assignments)

1	To apply the artificial immune pattern recognition to perform a task of structure damage Classification.
2	Implement DEAP (Distributed Evolutionary Algorithms) using Python.
3	Design and develop a distributed Hotel booking application using Java RMI. A distributed hotel booking system consists of the hotel server and the client machines. The server manages hotel rooms booking information. A customer can invoke the following operations at his machine i) Book the room for the specific guest ii) Cancel the booking of a guest.
4	Design and develop a distributed application to find the coolest/hottest year from the available weather data. Use weather data from the Internet and process it using MapReduce.
5	Implement Ant colony optimization by solving the Traveling salesman problem using python Problem statement- A salesman needs to visit a set of cities exactly once and return to the original city. The task is to find the shortest possible route that the salesman can take to visit all the cities and return to the starting city.
6	Create and Art with Neural style transfer on given image using deep learning.

Learning Resources

Text Books:

1. Nazmul Siddique, HojjatAdeli, "Computational Intelligence, Synergies of Fuzzy logic, Neural Networks and Evolutionary computing", Wiley publication
2. Andreis P. Engelbrecht, "Computational Intelligence an introduction", 2nd edition, Wiley publication

Reference Books:

1. George Coulouris, Jean Dollimore, Tim Kindberg, & Gordon Blair, "Distributed Systems – Concept and Design", 5th edition, Pearson, ISBN: 978-13-214301-1
2. Randay Chow, Theodore Johnson, "Distributed Operating System and Algorithm Analysis", Pearson (LPE), ISBN: 978-81-317-2859-8.
3. Seyedali Mirjalili, "Evolutionary Algorithms and Neural Networks Theory and Applications, Studies in Computational Intelligence", Vol. 780, Springer, 2019, ISBN: 978-3-319-93024-4 Press, 1998
4. Sitendra Tamrakar, Shruti Bhargava Choubey, Abhishek Choubey, "Computational Intelligence in Medical Decision Making and Diagnosis Techniques and Applications", CRC Press, 2023

e-Resources:

1. <https://induraj2020.medium.com/implementation-of-ant-colony-optimization-using-python-solve-traveling-salesman-problem-9c14d3114475>
2. <https://blog.tensorflow.org/2018/08/neural-style-transfer-creating-art-with-deep-learning.html>
3. <https://www.professionalcipher.com/2018/04/design-and-develop-distributed-hotel-booking-application-using-java-rmi.html>

MOOC Courses:

1. Advanced Distributed systems: https://onlinecourses.nptel.ac.in/noc22_cs80/preview
2. Computational Intelligence Laboratory: <https://www.iit.demokritos.gr/labs/cil/>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417535: Computer Laboratory IV

Teaching Scheme: PR: 02 Hours/Week	Credit 02	Examination Scheme and Marks Term Work (TW): 50 Marks Practical (PR) : 25 Marks
---	----------------------------	--

Companion Course: Elective V (417531), Elective VI (417532)

Course Objectives:

- To understand the fundamental concepts and techniques of Virtual reality
- To understand Big Data Analytics Concepts
- To learn the fundamentals of software development for portable devices
- To understand fundamental concepts of Deep Learning
- To be familiar with the various application areas of augmented realities
- To introduce the concepts and components of Business Intelligence (BI)
- To understand the concepts of Information Systems

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Apply basic principles of elective subjects to problem solving and modeling

CO2: Use tools and techniques in area of software development to build mini projects

CO3: Design and develop applications on subjects of their choice

CO4: Implement and manage deployment, administration & security

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 is to be developed as a hands-on resource and reference. The instructor's manual needs to include a prologue (about the University/program/ institute/ department/foreword/ preface etc.), 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 students in the form of a 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, Database design, test cases, conclusion/analysis).

1. Students should submit term work in the form of the journal with write-ups based on a specified list of assignments.
2. Practical /Oral Examinations will be based on all the assignments in the lab manual.
3. Candidate is expected to know the theory involved in the experiment.
4. The practical/Oral examination should be conducted only if the journal of the candidate is complete in all respects.

Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work is done based on the overall performance and lab assignments performance of students. Each lab assignment assessment will assign grade/marks based on parameters (Attendance, conduction & viva). Suggested parameters for the overall evaluation as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality, and neatness.

1. Examiners will assess the student based on the performance of students considering the parameters such as timely conduction of practical assignment, the methodology adopted for the implementation of practical assignment, timely submission of assignment in the form of handwritten write-up along with results of the implemented assignment, attendance, etc.
2. Examiners will judge the understanding of the practices performed in the examination by asking some questions related to theory & implementation of experiments he/she has carried out.
3. The concerned faculty member should check appropriate knowledge of the usage of software and hardware related to the respective laboratory.

Guidelines for Oral/ Practical Examination

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

Guidelines for Laboratory Conduction

Set of Suggested assignment lists are provided in Groups – A and B. Each Student must perform at least 10 assignments (8 from Group A, 2 from Group B i.e. 1 Mini Project from each elective).

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

Programming tools recommended: SQL, PL/SQL, Front End: Java/Perl/PHP/Python/Ruby/.net, Backend: Monod/MYSQL/Oracle, Database Connectivity: ODBC/JDBC.

PART I (417531): ELECTIVE V

417531(A): Virtual Reality & Game Development

Perform any 5 Assignments.

1. Installation of Blender, setting up Blender for VR development, understanding documentation of the same.
2. Create a VR gallery space with a blender tool.
3. Create a 2D cube and apply pivot points snapping and proportional editing functions in blender.
4. Design a 3D cube shape in a blender, apply textures and shades in the object.
5. Create any shape and perform the effects using The Extrude, Inset, and Knife Tools using blender.
6. Create a simple Tic Tac Toe game using HTML5 and JavaScript and CSS.
7. Create a Dodge the Creeps 2D / 3D game using Godot Gaming Engine.

417531(B): Big Data Analytics

Perform any 5 Assignments.

1. Set up and Configuration Hadoop Using CloudEra/ Google Cloud BigQuery. Databricks Lakehouse Platform. Snowflake. Amazon Redshift.
2. Develop a MapReduce program to calculate the frequency of a given word in a given file.
3. Implement Matrix Multiplication using Map-Reduce

- | |
|---|
| 4. Develop a MapReduce program to find the grades of students. |
| 5. Develop a MapReduce program to analyze Titanic ship data and to find the average age of the people (only male) who died in the tragedy. How many persons are dead in each class (only female). |
| 6. Mongo DB: Installation and Creation of database and Collection CRUD Document: Insert, Query, Update and Delete Document. |
| 7. Hive: Introduction Creation of Database and Table, Hive Partition, Hive Built in Function and Operators, Hive View and Index. |
| 8. Visualization: Connect to data, Build Charts and Analyze Data, Create Dashboard, Create Stories using Tableau/PowerBI. |

417531(C): Software Development for portable devices

Perform any 5 Assignments.

- | |
|--|
| 1. Create a simple Android application using native Android Views and layouts |
| 2. Develop an app for motion detection. |
| 3. Develop an app to enable and disable Wi-Fi in Android. |
| 4. Develop an app to enable and disable Bluetooth in Android. |
| 5. App to demo SQLite - Insert, Update, Delete operation. App to demo to extract World Population information from the database. |
| 6. Develop Hello wear world by using android studio. |
| 7. Develop an app to get users current location. |

417531(D): Deep Learning

Perform any 5 Assignments.

- | |
|--|
| 1. Problem Statement – Real estate agents want help to predict the house price for regions in the USA. He gave you the dataset to work on and you decided to use the Linear Regression Model. Create a model that will help him to estimate what the house would sell for. |
|--|

URL for a dataset:

https://github.com/huzaifsayed/Linear-Regression-Model-for-House-Price-Prediction/blob/master/USA_Housing.csv

- | |
|--|
| 2. Build a Multiclass classifier using the CNN model. Use MNIST or any other suitable dataset. a. Perform Data Pre-processing b. Define Model and perform training c. Evaluate Results using confusion matrix. |
|--|

- | |
|--|
| 3. Design RNN or its variant including LSTM or GRU a) Select a suitable time series dataset. Example – predict sentiments based on product reviews b) Apply for prediction |
|--|

- | |
|--|
| 4. Design and implement a CNN for Image Classification a) Select a suitable image classification dataset (medical imaging, agricultural, etc.). b) Optimized with different hyper-parameters including learning rate, filter size, no. of layers, optimizers, dropouts, etc. |
|--|

- | |
|---|
| 5. Design and implement Deep Convolutional GAN to generate images of faces/digits from a set of given images. |
|---|

- | |
|---|
| 6. Perform Sentiment Analysis in the network graph using RNN. |
|---|

417531(E): Open Elective

Suitable set of Programming assignments for Open elective opted.

PART II (417532): ELECTIVE VI

417532(A): Augmented Reality

Perform any 5 Assignments.

- | |
|--|
| 1. Study of various AR VR Development tools. |
|--|

2. Case study of any single application using both VR and AR technologies.
3. Installation and understanding of UNITY 3D IDE.
4. Create a C# script that plays a video when an image is scanned using AR App (ARCore& Unity).
5. Develop & Deploy a simple marker-based AR app in which you have to write a C# program to play video on tracking a particular marker.
6. Develop and deploy an AR app, implement the following using Vuforia Engine developer portal:
 - i) Plane detection
 - ii) Marker based Tracking (Create database of objects to be tracked in Vuforia)
 - iii) Object Tracking

417532(B): Business Intelligence

Perform any 5 Assignments.

1. Import Data from different Sources such as (Excel, Sql Server, Oracle etc.) and load in targeted system.
2. Data Visualization from Extraction Transformation and Loading (ETL) Process
3. Perform the Extraction Transformation and Loading (ETL) process to construct the database in the Sql server / Power BI.
4. Data Analysis and Visualization using Advanced Excel.
5. Perform the data classification algorithm using any Classification algorithm
6. Perform the data clustering algorithm using any Clustering algorithm

417532(C): Information Systems Management

Perform any 5 Assignments.

1. Study Google Cloud Dataflow fully managed data processing service tool which is built to optimize computing power and automate resource management.
2. Study of different ETL Tools used in Enterprise used for Information System Management (Data Integration, Data Visualization, Reducing the cost of Project etc.).
3. Study Blue Ocean strategy. Prepare case study on any of the company (Example: NetFlix / Apple / Uber/ Airbnb/Starbuck)
4. Implement In-house or cloud-based ERP application system for small Enterprise with consideration of accurate information on a variety of organizational assets: Purchase like, Inventory
5. Use any data set in Google excel sheet, import to Google data studio an open-source tool for Extraction Transformation and Loading of information and visualize desired output. (sorting / data cleaning / filtering)
6. Think of a decision that you make in your daily life and build your own DSS using a spreadsheet that would help you make that decision.
7. To secure the information do research on the intellectual property portion of the End User License Agreement (EULA) on your project. Explain what the EULA is saying about protection of work

417532(D): Reinforcement Learning

Perform any 5 Assignments.

1. Study of the TensorFlow and OpenAI Gym Library
2. Develop a model-based RL algorithm, such as Monte Carlo Tree Search (MCTS), to solve a complex environment like Atari games.
3. Implement a Deep Q-Network (DQN) using a deep neural network library (e.g., TensorFlow or PyTorch) and train it on a simple environment like CartPole or Mountain Car.
4. Implement a policy gradient algorithms like REINFORCE or Proximal Policy Optimization (PPO) to solve a continuous control task.

5. Build a multi-agent environment, such as a cooperative or competitive game, and implement algorithms like Independent Q-Learning or Multi-Agent Deep Deterministic Policy Gradients (MADDPG).

6. Develop an actor-critic model using neural networks and train it on a classic RL benchmark, such as the Acrobot or Inverted Pendulum.

417532(E): Open Elective

Suitable set of Programming assignments for Open elective opted.

Learning Resources

Text Books:

Software Development for Portable Devices

1. Varun Nagpal, "Android Sensor Programming By Example", Packt Publishing, 2016, ISBN: 978-1-78528-550-9
2. Professional Android 4 Application Development, by Reto Meier, WROX Press, Wiley Publishing, 2012, ISBN: 978-1-118-10227-5
3. Sanjay M. Mishra, Wearable Android: Android Wear and Google FIT App Development, John Wiley & Sons, 2015, ISBN: 9781119050865

Virtual & Augmented Reality

1. Steve Aukstakalnism, "Practical Augmented Reality: A Guide to the Technologies, Applications and Human Factors for AR and VR", Addison-Wesley Professional, 2016, ISBN: 9780134094328
2. Allan Fowler, "Beginning iOS AR Game Development Developing Augmented Reality Apps with Unity and C#", 1st edition, Apress Publications, 2018, ISBN: 978-1484236178

Reinforcement Learning

1. Csaba Szepesvari, "Algorithms for Reinforcement Learning", Morgan and Claypool Publishers
2. Taweh Beysolow, "Applied Reinforcement Learning with Python", APRESS publications

Reference Books:

Virtual & Augmented Reality

1. Terry Norton, "Learning C# by Developing Games with Unity 3D Beginner's Guide", Packt publishing, 2017, ISBN-13: 978-1787286436
2. Jonathan Linowes, Krystian Babilinski, "Augmented Reality for Developers: Build practical augmented reality applications with Unity", ARCore, ARKit, and Vuforia

Information Systems Management

1. Grant Kemp Gerry White, "Google Data Studio for Beginner, Start Making Your Data Actionable", A press Media LLC, ISBN: 13 (electronic): 978-1-4842-5156-0
2. Adrian Payne, "Handbook of CRM: Achieving Excellence in Customer Management", Elsevier Ltd., ISBN-13: 978-07506-6437-0
3. Francis Buttle, "Customer Relationship Management Concepts and Technologies", Elsevier Ltd., ISBN: 978-1-85617-522-7
4. <http://www.faadooengineers.com/threads/17441-Enterprise-resource-planning-ebook-free-download-pdf>
5. https://www.academia.edu/6262473/Customer_Relationship_Management_Second_Edition

Reinforcement Learning

1. Phil Winder, "Reinforcement Learning: Industrial Applications of Intelligent Agents", O'Reilly Publications
2. Maxim Lapan, "Deep Reinforcement Learning Hands-On: Apply Modern RL Methods, with Deep Q-networks, Value Iteration, Policy Gradients, TRPO, AlphaGo Zero and More"

e-Books/web sources:

1. <http://nlp-iiith.vlabs.ac.in/>
2. Online links
Manual:<https://docs.unity3d.com/Packages/com.unity.xr.arfoundation@4.1/manual/index.html>
3. <https://rl-lab.com/>
4. https://ai.vub.ac.be/reinforcement-learning/?utm_source=www.google.com&utm_medium=organic&utm_campaign=Google&referreralrAnalytics=1
5. <https://mll.iiit.ac.in/projects/>

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417536: Project Stage II

Teaching Scheme: PR: 12 Hours/Week	Credit 06	Examination Scheme: Term Work: 100 Marks Oral: 50 Marks
---	----------------------------	--

Prerequisites Courses: Project Stage I (417527)

Course Objectives:

- To follow SDLC meticulously and meet the objectives of proposed work
- To test rigorously before deployment of system
- To validate the work undertaken
- To consolidate the work as furnished report

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Show evidence of independent investigation

CO2: Critically analyze the results and their interpretation

CO3: Report and present the original results in an orderly way and placing the openquestions in the right perspective

CO4: Link techniques and results from literature as well as actual research and futureresearch lines with the research

CO5: Appreciate practical implications and constraints of the specialist subject

Guidelines

In Project Work Stage-II, the student shall complete the remaining project work which consists of Selection of Technology and Tools, Installations, UML implementations, testing, Results, performance discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems and comparative analysis and validation of results and conclusions. The student shall prepare and submit the report of Project work in standard format for satisfactory completion of the work that is the duly certified by the concerned guide and head of the Department/Institute.

Follow guidelines and formats as mentioned in Project Workbook recommended by Board of Studies.

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417537: Audit Course 8

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 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.

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

- | | |
|--|---|
| <ul style="list-style-type: none"> • Lectures/ Guest Lectures • Visits (Social/Field) and reports • Demonstrations or presentations | <ul style="list-style-type: none"> • 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
- Presentation or Report

Audit Course 8 Options

Audit Course Code	Audit Course Title
AC8-I	Usability Engineering
AC8-II	Conversational Interfaces
AC8-III	Social Media and Analytics
AC8-IV	Foreign Language
AC8-V	MOOC-Learn New Skills

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417537: Audit Course 8
AC8-I: Usability Engineering

In this course you will have a hands-on experience with usability evaluation and user-centered design. This course will not help to learn how to implement user interfaces, but rather how to design based on the needs of users, which you will determine, and learn how to evaluate your designs rigorously. This help in knowing more about the usability; human computer interaction, the psychological aspects of computing, evaluation.

Course Objectives:

- To understand the human centered design process and usability engineering process and their roles in system design and development
- To know usability design guidelines, their foundations, assumptions, advantages, and weaknesses
- Understand the user interface based on analysis of human needs and prepare a prototype system

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Describe the human centered design process and usability engineering process and their roles in system design and development

CO2: Discuss usability design guidelines, their foundations, assumptions, advantages, and weaknesses

CO3: Design a user interface based on analysis of human needs and prepare a prototype system

CO4: Assess user interfaces using different usability engineering techniques

CO5: Present the design decisions

Course Contents

1. What Is Usability?: Usability and Other Considerations, Definition of Usability, Example: Measuring the Usability of Icons, Usability Trade-Offs, Categories of Users and Individual User Differences
2. Usability in Software Development: The Emergence of Usability, Human Computer Interaction, Usability Engineering
3. The usability Engineering Lifecycle: Requirement Analysis, Design, Testing, Development
4. Usability Assessment Methods beyond Testing
5. International User Interfaces

References:

1. Mary Beth Rosson, John Millar Carroll, “Usability Engineering: Scenario-based Development of Human-Computer Interaction”
2. Jakob Nielsen, “Usability Engineering”
3. Deborah J. Mayhew, “The usability engineering lifecycle”

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

- | | |
|---|---|
| <ul style="list-style-type: none"> ● Lectures/ Guest Lectures ● Visits (Social/Field) and reports ● Demonstrations | <ul style="list-style-type: none"> ● Surveys ● Mini-Project ● Hands on experience on focused topic |
|---|---|

A report of 15-20 pages contains any of the activity details mentioned above.

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417537: Audit Course 8
AC8-II: Conversational Interfaces

Effective information security at the enterprise level requires participation, planning, and practice. It is an ongoing effort that requires management and staff to work together from the same script. Fortunately, the information security community has developed a variety of resources, methods, and best practices to help modern enterprises address the challenge. Unfortunately, employing these tools demands a high degree of commitment, understanding, and skill attributes that must be sustained through constant awareness and training.

Course Objectives:

- To understand the basics of conversation
- To know the interactive environments for conversational skills
- To acquaint with the speech to text and text to speech techniques

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Develop an effective interface for conversation

CO2: Explore advanced concepts in user interface

Course Contents

1. **Introduction to Conversational Interface:** Preliminaries, Developing a speech based Conversational Interface, Conversational Interface and devices.
2. **A technology of Conversation:** Introduction, Conversation as Action, The structure of Conversation, The language of Conversation.
3. **Developing a Speech-Based Conversational Interface:** Implementing Text to Speech: Text Analysis, Wave Synthesis, Implementing Speech Recognition: Language Model, Acoustic Model, Decoding. Speech Synthesis Markup Language.
4. **Advanced voice user interface design**

References:

1. Cathy Pearl, “Designing Voice User Interfaces: Principles of Conversational Experiences”
2. Michael McTear, Zoraida Callejas, David Griol, “The Conversational Interface: Talking to Smart Devices”
3. Martin Mitrevski, “Developing Conversational Interfaces for iOS: Add Responsive Voice Control”
4. Srinivas Janarthanam, “Hands-On Chatbots and Conversational UI Development: Build chatbots”

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

- | | |
|---|---|
| <ul style="list-style-type: none"> ● Lectures/ Guest Lectures ● Visits (Social/Field) and reports ● Demonstrations | <ul style="list-style-type: none"> ● Surveys ● Mini-Project ● Hands on experience on focused topic |
|---|---|

A report of 15-20 pages contains any of the activity details mentioned above.

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417537: Audit Course 8
AC8-III: Social Media and Analytics

Course Objectives:

- To identify and classify social media data to undergo a situation Analysis
- To Understand and apply key concepts in social media metrics that shall improve decision-making
- To analyze Social Media databases to enable the development of new predictive models
- To develop strategy and measure for social media campaign effectiveness
- To create a better business decision by leveraging social media data

Course Outcomes:

After completion of the course, learners should be able to-

- CO1:** Recall the fundamental social media metrics ideas
CO2: Identify social media analytics software
CO3: Study the data from social media
CO4: Maintain an eye on customers and rivals to gather deeper consumer insights through sophisticated social media data modelling

Course Contents

1. Introduction to Social Media

Describe the various types of data that can often be found on social media networks.
 Recognize ethical issues to consider when gathering and using social data.
2. Modeling Building in Social Media

Get an extensive social media database loaded. Create summary statistics for an extensive data of social media.
3. Visualizing Social Media Networks

Get an extensive social media database loaded. Create summary statistics for an extensive data of social media. Case Study: Twitter/Facebook/

References:

1. Gohar F. Khan, “Creating Value with Social Media Analytics: Managing, Aligning, and Mining Social Media Text, Networks, Actions, Location, Apps, Hyperlinks, Multimedia, & Search Engines Data”
2. Randy Bartlett, “A Practitioner’s Guide to Business Analytics: Using Data Analysis Tools to Improve Your Organization’s Decision Making and Strategy”, IGBC Green New Buildings Rating System, Version 3.0, Abridged Reference Guide, 2014
3. By Matt Taddy, “Business Data Science: Combining Machine Learning and Economics to Optimize, Automate, Accelerate Business Decisions”

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

- | | |
|---|---|
| <ul style="list-style-type: none"> ● Lectures/ Guest Lectures ● Visits (Social/Field) and reports ● Demonstrations | <ul style="list-style-type: none"> ● Surveys ● Mini-Project ● Hands on experience on focused topic |
|---|---|

A report of 15-20 pages contains any of the activity details mentioned above.

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417537: Audit Course 8
AC8-IV: Foreign Language

Course Objectives:

- Get introduced to the Culture, Routine of the Foreign Society through language
- Meet the needs of ever growing foreign industry with respect to language support

Course Outcomes:

After completion of the course, learners-

CO1: Will have the ability of basic communication

CO2: Will have the knowledge of Language script

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

CO4: Will develop interest to pursue profession in Foreign Industry

Course Contents**Instructions:**

All course contents should be completed in only one language (German, French, Japanese and any other suitable foreign language)

1. **Introduction to the Foreign Language:** Introduction of Alphabets, Spell the names, Addresses, Numbers, Telephone numbers, OrdinalNumbers, Pin code Numbers, Dates, Birthdates, Age, days of the week, Months.
2. **Communication Part 1:** Basic Greetings, Personal Pronouns, Possessive Pronouns.
3. **Communication Part 2:** Self-Introduction, Introducing other people, about family, friends, course mates, seasons, and seasons in Other countries and in neighboring countries.

Text Books:

1. The Everything Learning German Book: Speak, write, and understand basic German in no time (Everything®) Kindle Edition with Audio/Video by Edward Swick (Author)
2. NETZWERK Deutsch als Fremdsprache A1(Goyal, New Delhi, 2015)
3. Japanese from Zero!, Book 1 by George Trombley, Yukari Takenaka

References:

1. Best Books for Learning French By David Issokson
2. Easy Spanish Step-By-Step By Barbara Bregstain

MOOC Courses:

1. [https://onlinecourses.nptel.ac.in/noc21_hs30/preview](https://onlinecourses.nptel.ac.in/noc21_hs30/)
2. <https://nptel.ac.in/courses/109106166>
3. <https://nptel.ac.in/courses/109106085>

e-Resources:

1. <https://www.coursera.org/browse/language-learning>
2. https://alison.com/?utm_source=google&utm_medium=cpc&utm_campaign=PPC_Tier-4_First-Click_Courses-Broad_&utm_adgroup=Product_Courses&gclid=CjwKCAjwhdWkBhBZEiwA1ibLmIZPl30Tg6Zd7UDPSU2vcB2J1doDOAi9SnBCElqJWK2_Hhdfo2iCSRoCGwkQAvD_BwE
3. FACTS ABOUT GERMANY <https://www.tatsachen-ueber-deutschland.de/en>
4. ONLINE GERMAN-ENGLISH DICTIONARY www.leo.org
5. PRACTICE MATERIAL <https://www.goethe.de/en/spr/kup/prf/prf/sd1/ueb.html>

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

- | | |
|---|---|
| <ul style="list-style-type: none"> • Lectures/ Guest Lectures • Visits (Social/Field) and reports • Demonstrations | <ul style="list-style-type: none"> • Surveys • Mini-Project • Hands on experience on focused topic |
|---|---|

A report of 15-20 pages contains any of the activity details mentioned above.

Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
417537: Audit Course 8
AC8-V: MOOC-Learn New Skills

Course Objectives:

- To promote interactive user forums to support community interactions among students, professors, and experts
- To promote learn additional skills anytime and anywhere
- To enhance teaching and learning on campus and online

Course Outcomes:

After completion of the course, learners should be able to-

CO1: To acquire additional knowledge and skill

CO2: Explore new areas of interest in a relevant field

Course Contents

MOOCs (Massive Open Online Courses) provide affordable and flexible ways to learn new skills, pursue lifelong interests and deliver quality educational experiences at scale. Whether you're interested in learning for yourself, advancing your career or leveraging online courses to educate your workforce, SWAYAM, NPTEL, edx or similar ones can help. World's largest SWAYAM MOOCs, a new paradigm of education for anyone, anywhere, anytime, as per your convenience, aimed to provide digital education free of cost and to facilitate hosting of all the interactive courses prepared by the best more than 1000 specially chosen faculty and teachers in the country. SWAYAM MOOCs enhance active learning for improving lifelong learning skills by providing easy access to global resources. SWAYAM is a programme initiated by the Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy. This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses. The courses hosted on SWAYAM are generally in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multimedia and state of the art pedagogy / technology. In order to ensure best quality content is produced and delivered, seven National Coordinators have been appointed: They are NPTEL for engineering and UGC for post-graduation education. Guidelines: Instructors are requested to promote students to opt for courses (not opted earlier) with proper mentoring. The departments will take care of providing necessary infrastructural and facilities for the learners. Learning can also be more interesting by knowledge sharing through different blogs, learning communities and social media platforms.

References:

1. <https://swayam.gov.in/>
2. <https://onlinecourses.nptel.ac.in/>
3. <https://www.edx.org>
4. <https://www.mygreatlearning.com/academy>
5. <https://www.simplilearn.com>

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

- | | |
|---|---|
| <ul style="list-style-type: none"> ● Lectures/ Guest Lectures ● Visits (Social/Field) and reports ● Demonstrations | <ul style="list-style-type: none"> ● Surveys ● Mini-Project ● Hands on experience on focused topic |
|---|---|

A report of 15-20 pages contains any of the activity details mentioned above.

Task Force Curriculum Design

Advisory Members and Members of Board of Studies

Dr. Nilesh J. Uke (Chairman)
 Dr. Pramod D. Patil
 Dr. Sachin R. Sakhare
 Dr. Vaishali V. Vikhe
 Dr. Dhananjay B. Kshirsagar

Dr. Amol D. Potgantwar
 Dr. Vandana Dhingra
 Dr. Balwant A. Sonkamble
 Dr. Pradip M. Jawandhiya
 Dr. Dipak V. Patil

Dr. Sachin D. Babar
 Dr. Deepali M. Ujalambkar
 Dr. Dipti D. Patil,
 Dr. Suhasini A. Itkar
 Dr. Sandip G. Deshmukh

Compilation

Dr. Darshan Medhane

Teams for Course Design

Name of Course	Team Coordinator	Team Members	
Machine Learning	Dr. M. A. Thalor	Dr. K. R Nirmal Pradnya Bachhav P.A. Puranik S. V. Gavhane A. S. More	Dr. P. A. Bailke V. G. Kshirsagar Kushal Sharma B. C. Garaware Tushar Kute K. A. Patil
Data Modeling & Visualization	Dr. Araddhana Deshmukh	Shubhangi Suryavanshi Nachiket Kulkarni Dr. Sujata Rao	Devyani Bonde Sankalp Giridhar
Elective III: Quantum Artificial Intelligence	Dr. A. Y. Chaudhari	Dr. H. B. Jadhav Sita Yadav P. B. Koli Manjusha Tatiya	Dr. Harsh Sahu Dr. Amit Saxena Uma Karanje Dr. Preeti Mulay Lahare Prasad
Elective III: Industrial Internet of Things	Dr. Suvarna Patil	Pallavi Yevale Dr. M. V. Kadam C. S. Bhosale Rohini Hanchate D. S. Bhadane A. P. Shinde	Swati Tawade Swati Jaiswal Sagar Kharde Dr. M. V. Kadam Dr. Manisha Bhende
Elective III: Enterprise Architecture and Components	Pooja Mishra	Pooja Mishra P. P. Shevatekar Dipesh Agrawal Dr. Sagar Rane	Arpit Yadav Mily Lal Parinita Chate
Elective III: Bioinformatics	Dr. V. V. Puri	Dr. Brijendra Gupta Dr. Yogita Sinkar J. K. Rajput Dr. Monika Rokade N. V. Sharma	Dr. M. Venkatramana Dr. H. N. Singh Dr. P. D. Kunde Dr. S. B. Mane Pritam Ahire
Elective IV: GPU Programming and Architecture	S. A. Agrawal	Dr. J. R. Pansare Dr. Shrinivas Sonkar Shubhangi Suryawanshi D. J. Bonde	Swapnil Ingale V. U. Rathod S. B. Shinde
Elective IV: Information Retrieval	Dr. Naresh Thoutam	Dr. Yogendra Patil Vinay Nalawade Kuldeep Hule Sagar Rajebhosale	Dr. Shraddha Konde Dr. Rajesh Phursule T. Bhaskar

Elective IV: Optimization Algorithms	Digambar Padulkar	Dr. Ajitkumar Shitole Dr Pushkar Joglekar	Santosh Kalegore Dr. Amol Admuthe
Computer Laboratory I	Dr. Meenakshi A.Thalor	N. B. Madke Sneha Salvekar Chetan Patil Shwetal Patil Devyani Bonde	Dr. Araddhana Deshmukh Shubhangi Suryavanshi Nachiket Kulkarni Dr. Sujata Rao Sankalp Giridhar
Computer Laboratory II	Dr. Suvarna Patil	Pallavi Yevale Dr. A. Y. Chaudhari Pooja Mishra Dr. V. V. Puri	Dr. D. V. Medhane S. A. Agrawal Digambar Padulkar Dr. Naresh Thoutam
Audit Course 7	Dr. Latika R. Desai	Dr. Brijendra Gupta	Jameer Kotwal
Computational Intelligence	Dikshendra Sarpate	V. G. Kshirsagar Manjusha Tatiya Sinu Nambiar Dr. Swapnaja Ubale	Milind Ankaleshwar Dipak Pawar Dr. Nilesh Sable Lahare P. A.
Distributed Computing	Dr. Rajiv R. Bhandari	P. B. Koli S. M. Chitalkar Arya Singh Nilesh Sharma Dr. Shivaji Lahane	Rahul Kotecha Sagar Ikhankar Swanand Sathe Dr. Devyani Bhamare Surbhi Pagar
Elective V: Virtual Reality and Game Development	Shubhangi Vairagar	Priyanka Savadekar Deptii Chaudhari	Yogita Hande Sukesh Kohari Sandip Hire
Elective V: Big Data analytics	Dr. Priya Pise	B. A. Khivsara V. R. Vasekar R. N. Wagh Dr. Saurabh Saoji	Ajit Lande Santosh Chavan Manisha R. Patil
Elective V: Software Development for Portable Devices	Dr. Nisha Auti	Kuldeep Hule Pooja Patil Dr. Kalpana Metre	Ishwari Pund T. Bhaskar Renuka Vaidya
Elective V: Deep Learning	Jameer Kotwal	Aparna Kulkarni	Sharad Adsure
Elective VI: Augmented Reality	Lahare P. A.	V. K. Abhang Manisha Patil R. D. Ghode S. G. Chordiya	Abhinandan Satpute Yogesh Kawade A. S. Pingle
Elective VI: Business Intelligence	Kapadnis J. Y.	V. S. Nalawade D. S. Bhadane Sarika Pawar	S. A. Shivarkar B. A. Khivsara Vipin Wani
Elective VI: Information Systems Management	Dr. M. A. Wakchaure	G. P. Mohole P. P. Ghorpade	Deepali Shinde S. B. Patil
Elective VI: Reinforcement Learning	Ingale V. S.	Agrawal R. A.	Kokane C. D.
Computer Laboratory III	Dr. Rajiv R. Bhandari	Dikshendra Sarpate	
Computer Laboratory IV	Dr. M. A. Wakchaure	Shubhangi Vairagar Dr. Priya Pise Dr. Nisha Auti	Ingale V. S. Kapadnis J. Y. Lahare P. A. Jameer Kotwal
