

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



**Curriculum  
for  
Second Year of Computer Engineering  
(2019 Course)  
(With effect from 2020-21)**

**Savitribai Phule Pune University**  
**Bachelor of Computer Engineering**  
**Program Outcomes (PO)**

**Learners are expected to know and be able to—**

<b>PO1</b>	<b>Engineering knowledge</b>	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems
<b>PO2</b>	<b>Problem analysis</b>	Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences
<b>PO3</b>	<b>Design / Development of Solutions</b>	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
<b>PO4</b>	<b>Conduct Investigations of Complex Problems</b>	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.
<b>PO5</b>	<b>Modern Tool Usage</b>	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
<b>PO6</b>	<b>The Engineer and Society</b>	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
<b>PO7</b>	<b>Environment and Sustainability</b>	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development
<b>PO8</b>	<b>Ethics</b>	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice
<b>PO9</b>	<b>Individual and Team Work</b>	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
<b>PO10</b>	<b>Communication Skills</b>	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
<b>PO11</b>	<b>Project Management and Finance</b>	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.
<b>PO12</b>	<b>Life-long Learning</b>	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

**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course) (With effect from Academic Year 2020-21)**

**Semester-III**

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	Mid-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
210241	<a href="#">Discrete Mathematics</a>	03	-	01	30	70	-	-	-	100	03	--	01	04
210242	<a href="#">Fundamentals of Data Structures</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
210243	<a href="#">Object Oriented Programming</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
210244	<a href="#">Computer Graphics</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
210245	<a href="#">Digital Electronics and Logic Design</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
210246	<a href="#">Humanity and Social Science</a>	-	-	01	-	-	-	-	-	-	-	-	-	-
210247	<a href="#">Data Structures Lab</a>	-	04	-	-	-	25	50	-	75	-	02	-	02
210248	<a href="#">OOP and Computer Graphics Lab</a>	-	04	-	-	-	25	50	-	75	-	02	-	02
210249	<a href="#">Digital Electronics Lab</a>	-	02	-	-	-	25	-	-	25	-	01	-	01
210250	<a href="#">Business Communication Skills Lab</a>	-	02	-	-	-	25	-	-	25	-	01	-	01
210251	<a href="#">Audit Course 3</a>	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Total Credit</b>										<b>15</b>	<b>06</b>	<b>01</b>	<b>22</b>	
<b>Total</b>		<b>15</b>	<b>12</b>	<b>02</b>	<b>150</b>	<b>350</b>	<b>100</b>	<b>100</b>	<b>-</b>	<b>700</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

**Semester-IV**

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	Mid-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
210252	<a href="#">Mathematics III</a>	03	-	01	30	70	-	-	-	100	03	--	01	04
210253	<a href="#">Data Structures and Algorithms</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
210254	<a href="#">Software Engineering</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
210255	<a href="#">Microprocessor</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
210256	<a href="#">Principles of Programming Languages</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
210257	<a href="#">Data Structures and Algorithms Lab</a>	-	04	-	-	-	25	50	-	75	-	02	-	02
210258	<a href="#">Microprocessor Lab</a>	-	04	-	-	-	25	50	-	75	-	02	-	02
210259	<a href="#">Code of Conduct</a>	-	-	01	-	-	-	-	-	-	-	-	-	-
210260	<a href="#">Project Based Learning</a>	-	04	-	-	-	50	-	-	50	-	02	-	02
210261	<a href="#">Audit Course 4</a>	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Total Credit</b>										<b>15</b>	<b>06</b>	<b>01</b>	<b>22</b>	
<b>Total</b>		<b>15</b>	<b>12</b>	<b>02</b>	<b>150</b>	<b>350</b>	<b>100</b>	<b>100</b>	<b>-</b>	<b>700</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

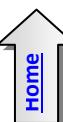
## Abbreviations:

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

## Note:

### For each course-

- The course objectives, course outcomes and CO-PO mapping table are provided for reference; the course instructor is requested to modify as per his perspective.
- #Exemplar/Case Studies are included at each unit to explore how the learned topics applies to real world situations and are to be designed so as to assist students to increase their understanding of particular skills, content or knowledge in any given situation and articulate. One or two sample exemplar or case study are included for each unit, instructor may extend the same with more.
- #Exemplar/Case Studies may be assigned as self study by students and to be excluded from theory examinations.
- For each unit, content attainment mapping is indicated with course outcome(s). Instructor may update the same.
- @ CO & PO (Course Objectives and Program Outcomes) Attainment Mapping Table: The CO-PO mapping in the table at end of course contents, indicates the correlation levels of 3, 2, 1 and '-'. The notation of 3, 2 and 1 denotes substantially (high), moderately (medium) and slightly (low). The meaning of '-' is no correlation between CO and PO.
- Set of suggested Laboratory assignments is provided for reference. Laboratory Instructor may design suitable set of assignments for respective institute.
- For each laboratory assignment, it is compulsory for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set (if applicable), comparative/complexity analysis.
- For each course and laboratory, instructor should motivate students to read article/research paper related to recent development and invention in the field.
- Laboratory conduction and assessment guidelines are to be strictly followed.



**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210241: Discrete Mathematics**

Teaching Scheme:	Credit	Examination Scheme:
<b>TH: 03 Hours/Week</b>	<b>04</b>	<b>Mid_Semester(TH): 30 Marks</b>
<b>TUT: 01 Hours/Week</b>		<b>End_Semester(TH): 70 Marks</b>

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

**Companion Course, if any:** ---

**Course Objectives:**

- To use appropriate set, function and relation models to understand practical examples, and interpret the associated operations and terminologies in context.
- Determine number of logical possibilities of events.
- Learn logic and proof techniques to expand mathematical maturity.
- Formulate problems precisely, solve the problems, apply formal proof techniques, and explain the reasoning clearly.

**Course Outcomes:**

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

- CO1: Design and analyze real world engineering problems by applying set theory, propositional logic and mathematical induction  
 CO2: Develop skill in expressing mathematical properties of relation and function  
 CO3: Identify number of logical possibilities of events to design professional engineering Solutions  
 CO4: Model and solve computing problem using tree and graph Analyze the properties of binary operations and evaluate the algebraic structure  
 CO5: Apply abstract algebra in combinatorics, coding theory and questions regarding geometric constructions

**Course Contents**

<b>Unit I</b>	<b>Set Theory and Logic</b>	<b>(06 Hours)</b>
Introduction and significance of Discrete Mathematics, <b>Sets</b> - Naïve Set Theory (Cantorian Set Theory), Axiomatic Set Theory, Set Operations, Cardinality of set, Principle of inclusion and exclusion. <b>Types of Sets</b> – Bounded and Unbounded Sets, Diagonalization Argument, Countable and Uncountable Sets, Finite and Infinite Sets, Countably Infinite and Uncountably Infinite Sets, Power set, <b>Propositional Logic</b> - logic, Propositional Equivalences, Application of Propositional Logic- Translating English Sentences, Proof by Mathematical Induction and Strong Mathematical Induction		
<b>#Exemplar/Case Studies</b>	Know about the great philosophers- Georg Cantor, Richard Dedekind and Aristotle	
<b>Mapping of Course Outcomes for Unit I</b>	CO1, CO3	
<b>Unit II</b>	<b>Relations and Functions</b>	<b>(06 Hours)</b>
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. <b>Functions</b> - Surjective, Injective and Bijective functions, Identity function, Partial function, Invertible function, Constant function, Inverse functions and Compositions of functions, The Pigeonhole Principle.		
<b>#Exemplar/Case Studies</b>	Know about the great philosophers-Dirichlet	
<b>Mapping of Course Outcomes for Unit II</b>	CO2	
<b>Unit III</b>	<b>Counting Principles</b>	<b>(06 Hours)</b>

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.

<b>#Exemplar/Case Studies</b>	Study Sudoku solving algorithms and algorithm for generation of new SUDOKU. Study Hank-shake Puzzle and algorithm to solve it
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<b>Mapping of Course Outcomes for Unit III</b>	
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<b>Unit IV</b>	<b>Graph Theory</b>	<b>(06 Hours)</b>
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.		

<b>#Exemplar/Case Studies</b>	Three utility problem, Web Graph, Google map
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<b>Mapping of Course Outcomes for Unit IV</b>	CO4
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<b>Unit V</b>	<b>Trees</b>	<b>(06 Hours)</b>
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).		

<b>#Exemplar/Case Studies</b>	Algebraic Expression tree, Tic-tac-toe game tree
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<b>Mapping of Course Outcomes for Unit V</b>	CO4, CO5
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<b>Unit VI</b>	<b>Algebraic Structures and Coding Theory</b>	<b>(06 Hours)</b>
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.		

<b>#Exemplar/Case Studies</b>	Cryptography used in world war II
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<b>Mapping of Course Outcomes for Unit VI</b>	CO6
<b>Learning Resources</b>	

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

<b>e-Books</b>
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<b>MOOC Courses:</b>
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### @The CO-PO Mapping Table

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

CO4	3	3	3	2	-	-	-	-	-	-	-	-	-
CO5	3	3	3	2	-	-	-	-	-	-	-	-	-
CO6	3	3	3	2	-	-	-	-	-	-	-	-	-



**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210242: Fundamentals of Data Structures**

Teaching Scheme:	Credit	Examination Scheme:
TH: 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:** 210247: Data Structures Laboratory

**Course Objectives:**

- To understand the basic techniques of algorithm analysis.
- To understand various algorithmic strategies to approach the problem solution.
- To understand the memory requirement for various data structures.
- To understand various data searching and sorting methods with pros and cons.
- To acquaint with the structural constraints and advantages in usage of the data.
- To understand the standard and abstract data representation methods.
- To identify the appropriate data structure and algorithm design method for a specified application.

**Course Outcomes:**

- CO1: To demonstrate a detailed understanding of behaviour of data structures like array, linked list, stack, and queue by developing programs.  
 CO2: To use appropriate algorithmic strategy for better efficiency  
 CO3: To summarize data searching and sorting techniques.  
 CO4: To discriminate the usage of various structures in approaching the problem solution.  
 CO5: To analyze and use effective and efficient data structures in solving various Computer Engineering domain problems.  
 CO6: To design the algorithms to solve the programming problems.

**Course Contents**

Unit I	Introduction to Algorithm and Data Structures	(07 Hours)
Introduction: From Problem to Data Structure (Problem, Logic, Algorithm, and Data Structure).		
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	CO3, CO5, CO6	
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.

<b>#Exemplar/Case Studies</b>	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.
<b>Mapping of Course Outcomes for Unit II</b>	CO1, CO2, CO3

<b>Unit III</b>	<b>Searching and Sorting</b>	<b>(06 Hours)</b>
<b>Searching:</b> Search Techniques-Sequential Search/Linear Search, Variant of Sequential Search- Sentinel Search, Binary Search, Fibonacci Search, and Indexed Sequential Search.		
<b>Sorting:</b> 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.		

<b>#Exemplar/Case Studies</b>	Use of Fibonacci search in non-uniform access memory storage and in Optimization of Unimodal Functions. Timsort as a hybrid stable sorting algorithm
<b>Mapping of Course Outcomes for Unit III</b>	CO1, CO3, CO4

<b>Unit IV</b>	<b>Linked List</b>	<b>(07 Hours)</b>
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.		
<b>#Exemplar/Case Studies</b> Garbage Collection		

<b>Mapping of Course Outcomes for Unit IV</b>	CO1, CO2, CO5
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<b>Unit V</b>	<b>Stack</b>	<b>(07 Hours)</b>
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.		
<b>#Exemplar/Case Studies</b> Android- multiple tasks/multiple activities and back-stack , Tower of Hanoi, 4 Queens problem.		

<b>Mapping of Course Outcomes for Unit V</b>	CO1, CO2, CO5, CO6
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<b>Unit VI</b>	<b>Queue</b>	<b>(06 Hours)</b>
Basic concept, Queue as Abstract Data Type, Representation of Queue using Sequential organization, Queue Operations, Circular Queue and its advantages, Multi-queues, Linked Queue and Operations. Deque-Basic concept, types (Input restricted and Output restricted), Priority Queue- Basic concept, types(Ascending and Descending).		
<b>#Exemplar/Case Studies</b> Priority queue in bandwidth management		

<b>Mapping of Course Outcomes for Unit VI</b>	CO1, CO2, CO5, CO6
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### Learning Resources

**Text Books:**

- Horowitz and Sahani—Fundamentals of Data Structures in C++, University Press, ISBN 10: 0716782928 ISBN 13: 9780716782926.
- 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. Brassard & Bratley —Fundamentals of Algorithmic Prentice Hall India/Pearson Education, ISBN 13-9788120311312.
2. Allen Downey, Jeffery Elkner, Chris Meyers-How to think like a Computer Scientist: Learning with Python, Dreamtech Press, ISBN:9789351198147.
3. R. Gillberg, B. Forouzn —Data Structures: A Pseudo code approach with C, Cengage Learning, ISBN: 9788131503140.
4. M. Weiss—Data Structures and Algorithm Analysis in C++, 2nd edition, Pearson Education, 2002, ISBN-81-7808-670-0.

**e-Books:****MOOC:****Other:**

- Know Thy Complexities! (<https://www.bigocheatsheet.com/>) (<https://github.com/RehanSaeed/.NET-Big-O-Algorithm-Complexity-Cheat-Sheet>)
- Data Structure Visualizations (<https://www.cs.usfca.edu/~galles/visualization/Algorithms.html>)
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## @The CO-PO mapping table

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



**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210243: Object Oriented Programming**

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

**Prerequisite Courses, if any:** Good understanding of Programming and Problem Solving concepts

**Companion Course, if any:**

**Course Objectives:**

- To explore & understand the principles of Object Oriented Programming (OOP).
- To use the object-oriented paradigm in program design.
- To provide object-oriented programming insight using C++
- To lay a foundation for advanced programming.

**Course Outcomes:**

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

- CO1: Analyze the strengths of object oriented programming  
 CO2: Design and apply OOP principles for effective programming  
 CO3: Develop the application using object oriented programming language(C++)  
 CO4: Apply object-oriented concepts for advanced programming.

**Course Contents**

Unit I	Fundamentals of Object Oriented Programming (06 Hours)
Introduction to procedural, modular, generic and object-oriented programming techniques, limitations of procedural programming, Need of object-oriented programming, OOP Paradigms, 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. <b>C++ Programming-</b> C++ programming Basics, Data Types, Structures, Enumerations, control structures, Arrays and Strings, Class, Object, class and data abstraction, Access specifiers, separating interface from implementation. <b>Functions-</b> 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
Unit II	Inheritance and Pointers (06 Hours)
<b>Inheritance-</b> 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. <b>Pointers:</b> 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 popular softwares developed using C++			
Mapping of Course Outcomes for Unit II	CO2, CO3, CO4			
<b>Unit III</b>	<b>Polymorphism</b>	<b>(06 Hours)</b>		
Polymorphism- Introduction to Polymorphism, Early and late binding, 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			
<b>Unit IV</b>	<b>Files and Streams</b>	<b>(06 Hours)</b>		
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, CO3, CO4			
<b>Unit V</b>	<b>Exception Handling &amp; Templates</b>	<b>(06 Hours)</b>		
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 typename 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, CO3, CO4			
<b>Unit VI</b>	<b>Standard Template Library (STL)</b>	<b>(06 Hours)</b>		
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, CO3, CO4			
<b>Learning Resources</b>				
<b>Text Books:</b>				
<ol style="list-style-type: none"> <li>1. E Balagurusamy Object-Oriented Programming with C++.7<sup>th</sup> edition.McGraw-Hill Publication, ISBN 10: 9352607996 ISBN 13: 9789352607990</li> <li>2. Robert Lafore, — Object-Oriented Programming in C++ , fourth edition, Sams Publishing, ISBN:0672323087 (ISBN 13: 9780672323089</li> </ol>				

**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. Cox Brad, Andrew J. Novobilski, —Object –Oriented Programming: An Evolutionary Approach , Second Edition, Addison–Wesley, ISBN:13:978-020-1548341
4. Deitel, "C++ How to Program", 4<sup>th</sup> Edition, Pearson Education, ISBN:81-297-0276-2

**e-Books****MOOC Courses:**

@The CO-PO mapping table

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



**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210244: Computer Graphics**

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

**Prerequisite Courses, if any:**

**Companion Course, if any: OOP**

**Course Objectives:**

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

**Course Outcomes:**

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

- CO1: Define basic terminologies of Computer Graphics, interpret the mathematical foundation of the concepts of computer graphics and apply mathematics to develop Computer programs for elementary graphic operations.
- CO2: Define the concept of windowing and clipping and apply various algorithms to fill and clip polygons.
- CO3: Explain the core concepts of computer graphics, including transformation in two and three dimensions, viewing and projection.
- CO4: Explain the concepts of color models, lighting, shading models and hidden surface elimination.
- CO5: Describe the fundamentals of curves, fractals, animation and gaming.

**Course Contents**

Unit I	Graphics Primitives and Scan Conversion Algorithms	(06 Hours)
Introduction, graphics primitives - pixel, resolution, aspect ratio, frame buffer. Display devices, applications of computergraphics.		
<b>Introduction to OpenGL</b>	OpenGL architecture, primitives and attributes, simple modelling and rendering of two- and three-dimensional geometric objects, GLUT, interaction, events and call-backs picking. <b>(Simple Interaction with the Mouse and Keyboard)</b>	
<b>Scan conversion:</b>	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	
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

#### Mapping of Course Outcomes for Unit II

CO2

#### 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 softwares.

#### Mapping of Course Outcomes for Unit III

CO3

#### Unit IV

#### Light, Colour, Shading and Hidden Surfaces

(06 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

CO4

#### Unit V

#### Curves and Fractals

(06 Hours)

**Curves:** Introduction, Interpolation and Approximation, Blending function, B-Spline curve, Bezier curve,

**Fractals:** Introduction, Classification, Fractal generation: snowflake, Triadic curve, Hilbert curve, Applications.

#### #Exemplar/Case Studies

Case study on measuring the length of coastline using fractals

#### Mapping of Course Outcomes for Unit V

CO5

#### Unit VI

#### Introduction to Animation and Gaming

(06 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 tool s. a. Unity/Maya/Blender

#### Mapping of Course Outcomes for Unit VI

CO5

#### 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.
1. 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 McGrawHill Publication, 2002, ISBN 0 – 07 – 048677 – 8.

**e-Books****MOOC Courses:**

@The CO-PO mapping table

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



**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210245: Digital Electronics and Logic Design**

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

**Prerequisite Courses, if any:** 104010 Basic Electronics Engineering

**Companion Course, if any:** 210249 Digital Electronics Lab

**Course Objectives:**

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

**Course Outcomes:**

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

- CO1: Simplify Boolean Expressions using K Map.
- CO2: Design and implement combinational circuits.
- CO3: Design and implement sequential circuits.
- CO4: Develop simple real-world application using ASM and PLD.
- CO5: Choose appropriate logic families IC packages as per the given design specifications.
- CO6: Explain organization and architecture of computer system

**Course Contents**

<b>Unit I</b>	<b>Minimization Technique</b>	<b>(06 Hours)</b>
Logic Design Minimization Technique :- Minimization of Boolean function using K-map(up to 4 variables) and Quine Mc-Clusky Method, Representation of signed number- sign magnitude representation ,1's complement and 2's complement form (red marked can be removed), Sum of product and Product of sum form, Minimization of SOP and POS using K-map.		
#Exemplar/Case Studies		
Mapping of Course Outcomes for Unit I		
<b>Unit II</b>	<b>Combinational Logic Design</b>	<b>(06 Hours)</b>
Code converter :- BCD, Excess-3, Gray code, Binary Code. Half- Adder, Full Adder, Half Subtractor, Full Subtractor, Binary Adder (IC 7483), BCD adder, Look ahead carry generator, Multiplexers (MUX): MUX (IC 74153, 74151), Cascading multiplexers, Demultiplexers (DEMUX)- Decoder (IC 74138, IC 74154), Implementation of SOP and POS using MUX, DMUX, Comparators (2 bit), Parity generators and Checker.		
#Exemplar/Case Studies		Combinational Logic Design of BCD to 7-segment display Controller
Mapping of Course Outcomes for Unit II		CO1, CO2
<b>Unit III</b>	<b>Sequential Logic Design</b>	<b>(06 Hours)</b>
Flip-Flop: SR, JK,D,T; Preset &Clear, Master Slave JK Flip Flops, Truth Tables and Excitation tables, Conversion from one type to another type of Flop Flop. Registers: SISO, SIPO, PISO, PIPO, Shift Registers, Bidirectional Shift Register, Ring Counter , Universal Shift Register Counters: Asynchronous Counter, Synchronous Counter, BCD Counter, Johnson Counter, Modulus of the counter ( IC 7490),Synchronous Sequential Circuit Design :Models- Moore and Mealy, State diagram and State Table ,Design Procedure, Sequence Generator and detector.		

#Exemplar/Case Studies	Electronic Voting Machine (EVM)			
Mapping of Course Outcomes for Unit III	CO2, CO3			
<b>Unit IV</b>	<b>Algorithmic State Machines and Programmable Logic Devices</b>	<b>(06 Hours)</b>		
Algorithmic State Machines: Finite State Machines (FSM) and ASM, ASM charts, notations, construction of ASM chart and realization for sequential circuits. PLDS:PLD, ROM as PLD, Programmable Logic Array (PLA), Programmable Array Logic (PAL), Designing combinational circuits using PLDs.				
#Exemplar/Case Studies	Wave form generator using MUX controller method			
Mapping of Course Outcomes for Unit IV	CO2, CO3, CO4			
<b>Unit V</b>	<b>Logic Families</b>	<b>(06 Hours)</b>		
Classification of logic families: Unipolar and Bipolar Logic Families, Characteristics of Digital ICs: Fan-in, Fan-out, Current and voltage parameters, Noise immunity, Propagation Delay, Power Dissipation, Figure of Merits, Operating Temperature Range, power supply requirements. Transistor-Transistor Logic: Operation of TTL NAND Gate (Two input ), TTL with active pull up, TTL with open collector output, Wired AND Connection, Tristate TTL Devices, TTL characteristics. CMOS: CMOS Inverter, CMOS characteristics, CMOS configurations- Wired Logic, Open drain outputs.				
#Exemplar/Case Studies	To study the various basic gate design using TTL/CMOS logic family			
Mapping of Course Outcomes for Unit V	CO3			
<b>Unit VI</b>	<b>Introduction to Computer Architecture</b>	<b>(06 Hours)</b>		
Introduction to Ideal Microprocessor – Data Bus, Address Bus, Control Bus. Microprocessor based Systems – Basic Operation, Microprocessor operation, Block Diagram of Microprocessor. Functional Units of Microprocessor – ALU using IC 74181, Basic Arithmetic operations using ALU IC 74181, 4-bit Multiplier circuit using ALU and shift registers. Memory Organization and Operations, digital circuit using decoder and registers for memory operations.				
#Exemplar/Case Studies	Microprocessor based system in Communication /Instrumentation Control			
Mapping of Course Outcomes for Unit VI	CO2, CO3, CO6			
<b>Learning Resources</b>				
<b>Text Books:</b>				
1. Modern Digital Electronics by R.P.Jain, 4 <sup>th</sup> Edition, ISBN 978-0-07-06691-16 Tata McGraw Hill 2. Digital Logic and Computer Design by Moris Mano, Pearson , ISBN 978-93-325-4252-5				
<b>Reference Books:</b>				
1. John Yarbrough, —Digital Logic applications and Design, Cengage Learning, ISBN – 13: 978-81-315-0058-3 2. D. Leach, Malvino, Saha, —Digital Principles and Applications , Tata McGraw Hill, ISBN – 13:978-0-07-014170-4. 3. Anil Maini, —Digital Electronics: Principles and Integrated Circuits , Wiley India Ltd, ISBN:978-81-265-1466-3. 4. Norman B & Bradley, —Digital Logic Design Principles, Wiley India Ltd, ISBN:978-81-265-1258-				
<b>MOOC Courses:</b>				
1. Digital Circuits, by Prof. Santanu Chattopadhyay , <a href="https://swayam.gov.in/nd1_noc19_ee51/preview">https://swayam.gov.in/nd1_noc19_ee51/preview</a> 2. Digital Circuits and Systems , Prof. S. Srinivasan <a href="https://nptel.ac.in/courses/117/106/117106086/">https://nptel.ac.in/courses/117/106/117106086/</a>				

## @The CO-PO mapping table

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

**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210246: Humanity & Social Science**

Teaching Scheme:	Credit	Examination Scheme:
TH: 01 Hours/Week	00	Mid_Semester(TH): NA End_Semester(TH): NA

**Prerequisite Courses, if any:** No prerequisites required

**Companion Course, if any:** NA

**Course Objectives:**

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

**Course Outcomes:**

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

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

CO2: Aware about their responsibilities towards society.

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

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

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

**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

## **Interactive Sessions to be conducted during Tutorial (in classroom)**

1. PREPARED SPEECH ON CURRENT AFFAIRS
  - a. Purpose – Get students to stay abreast and invested in national current affairs
  - b. Method – Each student has to read an editorial from any national paper (English), find out more information on the topic and present it to the class; ending the session with his/her opinion on the matter
  - c. Outcome – Awareness of national state of affairs. Improve on oratory skills. Instil the thinking and contemplative skills and form non-judgemental opinions about an issue
2. UNDERSTANDING INDIA'S CULTURAL DIVERSITY
  - a. Purpose – Expose students to the intricacies of Indian cultural across various states
  - b. Method – Each student (or a small group of students in case the number of students is large) has to pick a state and come to the tutorial session prepared with a PPT that will showcase the demographic, sociographic and cultural information of that state
  - c. Outcome – Information about the beauty of Indian cultural diversity. Enhance exploratory skill, communication skills and learn how to present using technological tools
3. WRITING AN ARTICLE ON ANY SOCIAL ISSUE
  - a. Purpose – Highlight various social and cultural evil malevolence existing in our country and express one's opinion on how it can be changed
  - b. Method – Each student will have to write a 200 word essay on any of existing social malice that is prevalent in society. On evaluation, the top 5 essays can be displayed on the college wall magazine and rewarded if deemed appropriate
  - c. Outcome – Learn to raise one's voice against the wrong doings in communities. Build writing skills, improve language and gain knowledge about how to write an impactful 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 BEHAVIOUR
  - a. Purpose – Augment proper social etiquette among students and make them responsible citizens
  - b. Method – Conduct a quiz on traffic rules using audio-visual aids or using dumb charades where one student has to enact the traffic rule and the others have to guess that rule
  - c. Outcome – Grasp of various traffic rules and driving etiquette. Build verbal and 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 BEHAVIOUR**

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

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

**2. MAKING A VIDEO ON SOCIAL WASTAGES.**

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

3. RELAY MARATHON (3 – 5 kms)
  - a. Purpose: Propagate a social message by way of a sport activity
  - b. Method: A group of students will begin the race with banner / placard in hand that contains a social message. The group runs for 500 meters and hands over the banner / placard to the next group of students. This chain of exchange will continue for 3 – 5 kms.
  - c. Outcome: Become aware of the need for fitness and encouragement towards healthier lifestyle. Students will also be able to express their creativity in terms of meaningful messages and gain attention towards worthy social causes from the community in and around the campus.
4. TREE PLANTATION ON CAMPUS
  - a. Purpose: Involve students to actively participate in environment protection and develop greener surroundings
  - b. Method: Each student will plant a sapling and take care of that plant until it is able to sustain itself. Alternatively, students can organize a tree plantation drive in a public area and nurture it
  - c. Outcome: Besides increase in plants in the locality, students will feel a sense of empowerment and become social contributors towards protecting the environment.
5. VISIT TO AN OLD AGE HOME / ORPHANAGE
  - a. Purpose: Build a sense of responsibility towards the less fortunate in our society and feel privileged to be able to effect real change in the world around us
  - b. Method: Students have to visit an old age home or orphanage in the vicinity of the college. They can interact with the inmates, probably donate utilities to the charity organization and/or probably stage a few inclusive activities with the residents of the place. After the visit, students can submit a brief report about their experience
  - c. Outcome: Learn first-hand about the conditions and social situations that the no-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
  - a. Purpose: Create awareness in themselves as well as people in the community on various social evils that need to be eradicated
  - b. Method: Students will prepare and enact a street play on any pertinent issues in society. The topics suggested can be perils of mobile phones / online fraud / safety for girls / mental and physical health of the youth.
  - c. Outcome: Allow students to deliberate and think deeply about the looming issues that is dogging our society and the future of the youth. This will also bring out the creative skills among the students and allow them to showcase their talent.
7. BUDDY / BIG BROTHER SYSTEM
  - a. Purpose: Include and involve the less fortunate children making them feel wanted and cared for as well as use the opportunity to share knowledge among school students.
  - b. Method: Students have to go to nearby schools after procuring appropriate permissions to teach a particular topic on either technical or non technical domains. Each student can choose to adopt 5 students from the class to be their mentor over a period of 1 year by staying in touch with them and helping them resolve their issues on academic or other matters.
  - c. Outcome: Appreciation and respect towards the responsibility of teaching. They will learn to be accountable as social contributors and bring about some change in the lives of the young students they mentor as Buddies or Big Brother.

### 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. 2. Nirmal, C.J., Human Rights in India: Historical, Social and Political Perspectives (Law in India), Oxford India
5. Rangarajan, Environmental Issues in India, Pearson Education.
6. University of Delhi, The Individual & Society, Pearson Education.
7. Wikipedia.org / wiki /social studies.
8. M. N. Srinivas, Social change in modern India, 1991, Orient Longman.
9. David Mandelbaum, Society in India, 1990, Popular.
10. Dr. Abha Singh, Behavioural Science : Achieving Behavioural Excellence for Success, Wiley.

**e-Books****MOOC Courses:****@The CO-PO Mapping Table**

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

**Following Fields are applicable for Tutorial of Humanity & Social Science****Tutors Role in HSS**

- 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 as possible 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



**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210247: Data Structures Laboratory**

<b>Teaching Scheme:</b> <b>PR: 04 Hours/Week</b>	<b>Credit</b> <b>02</b>	<b>Examination Scheme:</b> <b>TW: 25 Marks</b> <b>PR: 50 Marks</b>
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**Guidelines for Instructor's Manual**

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

**Guidelines for Student's Laboratory Journal**

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

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

**Guidelines for Laboratory Conduction**

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

Set of suggested assignment list is provided in groups- A, B, C, D, and E. Each student must perform at least 13 assignments as 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,

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

7	<p>Write a <b>python</b> Program for magic square. A magic square is an <math>n * n</math> matrix of the integers 1 to <math>n^2</math> 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 <math>n=5</math>. In this example, the common sum is 65.</p> <table border="1"> <tbody> <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> </tbody> </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
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16	14	7	5	23																						
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8	<p>Write a <b>python</b> program that determines the location of a saddle point of matrix if one exists. An <math>m \times n</math> matrix is said to have a saddle point if some entry <math>a[i][j]</math> is the smallest value in row <math>i</math> and the largest value in <math>j</math>.</p>																									
9	<p>Write a <b>python</b> program to compute following computation on matrix:</p> <ol style="list-style-type: none"> <li>Addition of two matrices</li> <li>Subtraction of two matrices</li> <li>Multiplication of two matrices</li> <li>Transpose of a matrix</li> </ol>																									
10	<p>Write a <b>python</b> program for sparse matrix realization and operations on it- Transpose, Fast Transpose and addition of two matrices</p>																									
	<b>Group B</b>																									
11	<ol style="list-style-type: none"> <li>Write a <b>python</b> 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.</li> <li>Write a <b>python</b> 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</li> </ol>																									
12	<ol style="list-style-type: none"> <li>Write a <b>python</b> 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</li> <li>Write a <b>python</b> 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.</li> </ol>																									
13	<p>Write a <b>python</b> 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.</p>																									
14	<p>Write a <b>python</b> program to store first year percentage of students in array. Write function for sorting array of floating point numbers in ascending order using</p> <ol style="list-style-type: none"> <li>Selection Sort</li> <li>Bubble sort and display top five scores.</li> </ol>																									
15	<p>Write a <b>python</b> program to store second year percentage of students in array. Write function for sorting array of floating point numbers in ascending order using</p> <ol style="list-style-type: none"> <li>Insertion sort</li> <li>Shell Sort and display top five scores</li> </ol>																									
16	<p>Write a <b>python</b> 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.</p>																									
17	<p>Write a <b>python</b> program to store 12<sup>th</sup> 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.</p>																									

18	Write <b>python</b> program to store 10 <sup>th</sup> 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
	<b>Group C</b>
19	<p>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:</p> <ul style="list-style-type: none"> <li>a) Add and delete the members as well as president or even secretary.</li> <li>b) Compute total number of members of club</li> <li>c) Display members</li> <li>d) Two linked lists exists for two divisions. Concatenate two lists.</li> </ul>
20	<p>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</p> <ul style="list-style-type: none"> <li>a) The list of available seats is to be displayed</li> <li>b) The seats are to be booked</li> <li>c) The booking can be cancelled.</li> </ul>
21	<p>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-</p> <ul style="list-style-type: none"> <li>a) Display free slots</li> <li>b) Book appointment</li> <li>c) Cancel appointment ( check validity, time bounds, availability)</li> <li>d) Sort list based on time</li> <li>e) Sort list based on time using pointer manipulation</li> </ul>
22	<p>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-</p> <ul style="list-style-type: none"> <li>a) Set of students who like both vanilla and butterscotch</li> <li>b) Set of students who like either vanilla or butterscotch or not both</li> <li>c) Number of students who like neither vanilla nor butterscotch</li> </ul>
23	<p>Write C++ program for storing binary number using doubly linked lists. Write functions-</p> <ul style="list-style-type: none"> <li>a) To compute 1's and 2's complement</li> <li>b) Add two binary numbers</li> </ul>
24	<p>Write C++ program to realize Set using Generalized Liked List (GLL) e.g. A ={ a, b, {c, d,e, {}}, {f,g}, h, l, {j,k}, l, m}. Store and print as set notation.</p>
	<b>Group D</b>
25	<p>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-</p> <ul style="list-style-type: none"> <li>a) To print original string followed by reversed string using stack</li> <li>b) To check whether given string is palindrome or not</li> </ul>

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.
<b>Group E</b>	
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 beginning 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.



**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210248: OOP and Computer Graphics Laboratory**

<b>Teaching Scheme:</b> <b>PR: 04 Hours/Week</b>	<b>Credit</b> <b>02</b>	<b>Examination Scheme:</b> <b>TW: 25 Marks</b> <b>PR: 50 Marks</b>
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**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.

**Part I : Computer Graphics Laboratory**

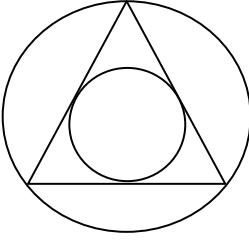
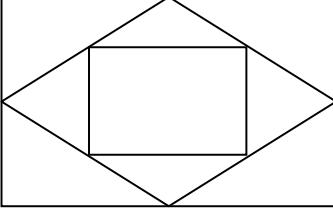
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Operating System recommended :- 64-bit Open source Linux or its derivative

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

**Suggested List of Laboratory Experiments/Assignments**  
**(Implementation of each problem statement is mandatory.)**

Sr. No.	<b>Group A</b>
1	Write C++ program to draw the line styles using DDA and Bresenham's algorithm (solid, dotted, dashed, dash dot and thick). Inherit pixel class and Use Constructors.
2	Write C++ program to draw a Circle using DDA and Bresenham's algorithm. Inherit pixel class and Use function overloading.
3	<p>a) Write C++ program to draw the following pattern. Use DDA and Bresenham's Line drawing algorithm</p>  <p style="text-align: center;"><b>OR</b></p> <p>b) Write C++ program to draw the following pattern. Use DDA and Bresenham's drawing algorithm</p> 
4	Write C++ program to draw a 4X4 chessboard. Use DDA and Bresenham's drawing algorithm to draw lines. Use Seed fill algorithm to fill black squares of the board
5	Write C++ program to draw a concave polygon and fill it with desired color using scan fill algorithm.
6	Write C++ program to implement Cohen Southerland line clipping algorithm.
Group B	
7	<p>a) Write C++ program to draw 2-D object and perform following basic transformations, Scaling b) Translation c) Rotation. Use operator overloading.</p> <p style="text-align: center;"><b>OR</b></p> <p>b) Write C++ program to implement translation, rotation and scaling transformations on equilateral triangle and rhombus.</p>

8	<p>a) Write a program to draw Bezier curve using basic concepts of Object oriented programming.</p> <p style="text-align: center;"><b>OR</b></p> <p>b) Write Program to draw Sine, Cosine and Tangent Curves using basic concepts of Object oriented programming.</p> <p style="text-align: center;"><b>OR</b></p> <p>c) Write C++ program to draw any object such as flower, waves using Bezier Curve generation technique.</p>
9	<p>a) Write C++ program to generate snowflake using concept of fractals using basic concepts of Object oriented programming.</p> <p style="text-align: center;"><b>OR</b></p> <p>b) Write C++ program to generate Hilbert curve using concept of fractals (use constructor).</p> <p style="text-align: center;"><b>OR</b></p> <p>c) Write C++ program to generate fractal patterns by using Koch curves using basic concepts of Object oriented programming.</p>
	<b>Group C</b>
10	<p>Write C++ program to simulate any one of or similar scene-</p> <p>a) Clock with pendulum                      <b>OR</b></p> <p>b) National Flag hoisting                    <b>OR</b></p> <p>c) Vehicle/boat locomotion                <b>OR</b></p> <p>d) Water drop falling into the water and generated waves after impact Kaleidoscope views generation (at least 3 colorful patterns)</p>
11	<p>a) Design and simulate any data structure like stack, queue, and trees visualization using graphics. Simulation should include all operations performed on designed data structure. Implement the same using OpenGL.</p> <p style="text-align: center;"><b>OR</b></p> <p>b) Write C++ program to draw 3-D cube and perform following transformations on it using OpenGL i) Scaling ii) Translation iii) Rotation about one axis.</p> <p style="text-align: center;"><b>OR</b></p> <p>c) Write OpenGL program to draw Sun Rise and Sunset.</p>
12	<p>a) Write a C++ Program control a ball using arrow keys.</p> <p style="text-align: center;"><b>OR</b></p> <p>b) Write a C++ Program to implement bouncing ball using sine wave form.</p> <p style="text-align: center;"><b>OR</b></p> <p>c) Write C++ program to draw Man Walking in the Rain with an Umbrella.</p> <p style="text-align: center;"><b>OR</b></p> <p>d) Write a C++ Program to make puzzle game.</p> <p style="text-align: center;"><b>OR</b></p> <p>e) Write a C++ Program to make Tic Tac Toe game</p>
	<b>Mini-Projects/ Case Study</b>
	Design and implement game / animation clip / Graphics Editor using open source graphics library.

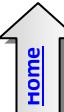
## Part II : Object Oriented Programming Laboratory

### Guidelines for Laboratory Conduction

## Suggested List of Laboratory Experiments/Assignments

<b>Sr. No.</b>	<b>Group A</b>
1	<p>Implement a class Complex which represents the Complex Number data type. Implement the following</p> <ol style="list-style-type: none"> <li>1. Constructor (including a default constructor which creates the complex number 0+0i).</li> <li>2. Overloaded operator+ to add two complex numbers.</li> <li>3. Overloaded operator* to multiply two complex numbers.</li> <li>4. Overloaded &lt;&lt; and &gt;&gt; to print and read Complex Numbers.</li> </ol>
2	<p>Write a C++ program create a calculator for an arithmetic operator (+, -, *, /). The program should take two operands from user and performs the operation on those two operands depending upon the operator entered by user. Use a switch statement to select the operation. Finally, display the result.</p>
3	<p>Develop an object oriented program in C++ to create a database of student information system containing the following information: Name, Roll number, Class, division, Date of Birth, Blood group, Contact address, telephone number, driving license no. and other.</p> <p>Construct the database with suitable member functions for initializing and destroying the data viz constructor, default constructor, Copy constructor, destructor, static member functions, friend class, this pointer, inline code and dynamic memory allocation operators-new and delete.</p>
4	<p>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 a publication.</p> <p>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).</p> <p>Write a program that instantiates the book and tape classes, allows user to enter data and displays the data members. If an exception is caught, replace all the data member values with zero values.</p>
5	<p>A book shop maintains the inventory of books that are being sold at the shop. The list includes details such as author, title, price, publisher and stock position. Whenever a customer wants a book, the sales person inputs the title and author and the system searches the list and displays whether it is available or not. If it is not, an appropriate message is displayed. If it is, then the system displays the book details and requests for the number of copies required. If the requested copies book details and requests for the number of copies required. If the requested copies are available, the total cost of the requested copies is displayed; otherwise the message Required copies not in stock is displayed. Design a system using a class called books with suitable member functions and Constructors. Use new operator in constructors to allocate memory space required. Implement C++ program for the system.</p>
6	<p>Create employee bio-data using following classes i) Personal record ii))Professional record iii)Academic record Assume appropriate data members and member function to accept required data &amp; print bio-data. Create bio-data using multiple inheritance using C++.</p>
<b>Group B</b>	
1	<p>Create User defined exception to check the following conditions and throw the exception if the criterion does not meet.</p> <ol style="list-style-type: none"> <li>a. User has age between 18 and 55</li> <li>b. User stays has income between Rs. 50,000 – Rs. 1,00,000 per month</li> <li>c. User stays in Pune/ Mumbai/ Bangalore / Chennai</li> <li>d. User has 4-wheeler</li> </ol> <p>Accept age, Income, City, Vehicle from the user and check for the conditions mentioned</p>

	above. If any of the condition not met then throw the exception
2	Write a C++ program that creates an output file, writes information to it, closes the file and open it again as an input file and read the information from the file.
3	Write a function template selection Sort. Write a program that inputs, sorts and outputs an integer array and a float array.
	<b>Group C</b>
1	Write C++ program using STL for sorting and searching with user defined records such as person record(Name, DOB, Telephone number), Item record (Item code, name, cost, quantity) using vector container
2	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.



**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210249: Digital Electronics Laboratory**

<b>Teaching Scheme:</b> <b>PR: 02 Hours/Week</b>	<b>Credit</b> <b>01</b>	<b>Examination Scheme:</b> <b>TW: 25 Marks</b>
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**Suggested List of Laboratory Experiments/Assignments**

<b>Sr. No.</b>	<b>Group A</b>
1	To Realize Full Adder/ Subtractor using a) Basic Gates and b) Universal Gates
2	Design and implement Code Converters-Binary to Gray and BCD to Excess-3
3	Design and Realization of BCD Adder using 4-bit Binary Adder (IC 7483).
4	Realization of Boolean Expression for suitable combination logic using MUX 74151 /74153, DMUX 74154/74138
5	To Verify the truth table of two bit comparators using logic gates.
6	Design & Implement Parity Generator and checker using EX-OR.
	<b>Group B</b>

7	Design and Realization: Flip Flop conversion
8	Design of 2 bit and 3 bit Ripple Counter using MS JK flip-flop.
9	Design of Synchronous 3 bit Up and Down Counter using MSJK Flip Flop / D Flip Flop
10	Realization of Mod -N counter using ( Decade Counter IC 7490 ) .
11	Design and implement Sequence generator (for Prime Number/odd and even ) using MS JK flip-flop
12	Design and implement Sequence detector using MS JK flip-flop
	<b>Group C</b>
13	Study of Shift Registers ( SISO,SIPO, PISO, PIPO)
14	Design of ASM chart using MUX controller Method.



**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210250: Business Communication Skills Laboratory**

<b>Teaching Scheme:</b> <b>PR: 02 Hours/Week</b>	<b>Credit</b> <b>01</b>	<b>Examination Scheme:</b> <b>TW: 25 Marks</b>
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**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), University syllabus, conduction & Assessment guidelines, topics under consideration concept objectives, outcomes, guidelines, references.

**Guidelines for Student's Laboratory Journal and Guidelines for Laboratory /TW Assessment**

The student must prepare the journal in the form of report elaborating the activities performed in the lab. Continuous assessment of laboratory work is to be done based on overall performance and Laboratory assignments performance of student. Each Laboratory assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each Laboratory assignment assessment include- timely completion, performance, 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.

**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.

**Suggested List of Laboratory Experiments/Assignments**

<b>Sr. No.</b>	<b>Suggested List of Laboratory Experiments/Assignments</b>
1	<p><b>SWOT analysis</b>  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</p>
2	<p><b>Personal &amp; Career Goal setting – Short term &amp; Long term</b>  The teacher should explain to them on how to set goals and provide template to write their short term and long term goals.</p>
3	<p><b>Public Speaking</b>  Any one of the following activities may be conducted :  <b>1. Prepared speech</b> (Topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver.) <b>2. Extempore speech</b> (Students deliver speeches spontaneously for 5 minutes each on a given topic) <b>3. Story telling</b> (Each student narrates a fictional or real life story for 5 minutes each) <b>4. Oral review</b> ( Each student orally presents a review on a story or a book read by them)</p>

4	<b>Reading and Listening skills</b> 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	<b>Group discussion</b> 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	<b>Letter/Application writing</b> 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	<b>Report writing</b> 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	<b>Resume writing-</b> Guide students and instruct them to write resume
9	<b>Presentation Skill</b> 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	<b>Team games for team building</b> - Students should make to participate in team activity.
11	<b>Situational games for role playing as leaders</b>
12	<b>Faculty may arrange one or more sessions from following:</b> Yoga and meditation. Stress management, relaxation exercises, and fitness exercises. Time management and personal planning sessions.
13	<b>Mock interviews-</b> guide students and conduct mock interviews
14	<b>Telephonic etiquettes</b> -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	<b>Email etiquettes</b> -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.



**Savitribai Phule Pune University**  
**Second Year of Engineering (2019 Course)**  
**210251: Audit Course 3**

In addition to credits, it is recommended that there should be audit course in preferably in each semester from second year. Student will be awarded the bachelor's degree if he/she earns 190 credits 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 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 in-semester 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):**

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

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

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

**Audit Course 3 Options**

<b>Audit Course Code</b>	<b>Audit Course Title</b>
<b>AC3-I</b>	Green Construction & Design
<b>AC3-II</b>	Social Awareness and Governance Program
<b>AC3-III</b>	Environmental Studies
<b>AC3-IV</b>	Smart Cities
<b>AC3-V</b>	Foreign Language (one of Japanese/Spanish/French/German). Course contents for <b>Japanese( Module 1)</b> are provided. For other languages institute may design suitably

## AC3-I: Green Construction & 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, student will be able to—

1. To understand the importance of environment friendly society.
2. To apply primary measures to reduce carbon emissions from their surroundings.
3. To learn role of IT solutions in design of green buildings.
4. To 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:

1. Hotels (economy, luxury, resorts )
2. Hospitals
3. Retail( big box, malls, small scale downtown retail)
4. Office
5. Government
6. Schools
7. Universities
8. Housing
9. Transportation Stations (Airport Terminals, Train Stations)

**References :**

1. Kibert, C. (2008) Sustainable Construction: Green Building Design and Delivery, 2nd edition(Hoboken, NJ: John Wiley & Sons).
2. Handbook of Green Building Design and Construction 1st Edition, by Sam Kubba, eBook ISBN:9780123851291.
3. 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)

## AC3-II: Social Awareness and Governance Program

**Prerequisites:**

Awareness about basic terms in Social Science and Governance

**Course Objectives:**

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

**Course Outcomes:**

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

1. Understand social issues and responsibilities as member of society.
2. Apply social values and ethics in decision making at social or organizational level
3. Promote obstacles in national integration and role of youth for National Integration
4. 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. Social Awareness and Personality Development by Devidas M. Muley , S Chand, ISBN: 812193074X.
2. Introduction to the Constitution of India, BhagabatiProsad Banerjee, Durga Das Basu, Shakeel Ahmad Khan, V. R. Manohar,ISBN : 9788180385599.

### AC3-III: Environmental Studies

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

#### **Course Objectives:**

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

#### **Course Outcomes:**

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

1. Comprehend the importance of ecosystem and biodiversity
2. To 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
3. Identify different types of environmental pollution and control measures
4. To 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, BioGeographical 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

## AC3-IV: Smart Cities

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

### **Course Objectives**

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

### **Course Outcomes**

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

1. Better understanding of the dynamic behavior of the urban system by going beyond the physical appearance and by focusing on representations, properties and impact factors
2. Exploration of the city as the most complex human-made organism with a metabolism that can be modeled in terms of stocks and flows
3. Knowledge about data-informed approaches for the development of the future city, based on crowd sourcing and sensing
4. Knowledge about the latest research results in for the development and management of future cities
5. Understanding 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. Norton & 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. Stan Geertman, Joseph Ferreira, Jr. Robert Goodspeed, John Stillwell, "Planning Support System ms and Smart Cities", Lecture notes in Geo information and Cartography, Springer.

## AC3-V: Foreign Language- Japanese (Module 1)

### **About course:**

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

Japanese is the new trend of 21st century. Not only youngsters but even the professionals seek value in it. It is the engineer’s companion in current times with an assertion of a thriving future. Pune has indisputably grown to become a major center of Japanese Education in India while increasing the precedence for Japanese connoisseurs.

Japanese certainly serves a great platform to unlock a notoriously tough market & 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 student

- Will have ability of basic communication.
- Will have the knowledge of Japanese script.
- Will get introduced to reading , writing and listening skills
- 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, yo Long vowels, Greetings and expressions
3. Self Introduction, Introducing other person, Numbers, Months, Dates, Telephone numbers, Stating on's age.

### **Reference:**

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-Inaugurates-Japan-centric-Delivery-Center-Pune.aspx](http://www.tcs.com/news_events/press_releases/Pages/TCS-Inaugurates-Japan-centric-Delivery-Center-Pune.aspx))



**Savitribai Phule Pune University  
Second Year of Engineering (2019 Course)  
210252: Mathematics III**

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

**Prerequisite Courses, if any:**

**Companion Course, if any:**

**Course Objectives:**

- 

**Course Outcomes:**

CO1:

**Course Contents**

Unit I	U	(07 Hours)
#Exemplar/Case Studies		
Mapping of Course Outcomes for Unit I	C	
Unit II	U	(07 Hours)
#Exemplar/Case Studies		
Mapping of Course Outcomes for Unit II		
Unit III	Unit Title	(06 Hours)
#Exemplar/Case Studies		
Mapping of Course Outcomes for Unit III		
Unit IV	Unit Title	(06 Hours)
#Exemplar/Case Studies		
Mapping of Course Outcomes for Unit IV		
Unit V	Unit Title	(06 Hours)

<b>#Exemplar/Case Studies</b>				
<b>Mapping of Course Outcomes for Unit V</b>				
<b>Unit VI</b>	<b>Unit Title</b>	<b>(06 Hours)</b>		
<b>#Exemplar/Case Studies</b>				
<b>Mapping of Course Outcomes for Unit VI</b>				
<b>Learning Resources</b>				
<b>Text Books:</b>				
1.				
<b>Reference Books:</b>				
1.				



**Savitribai Phule Pune University**  
**Second Year of Engineering (2019 Course)**  
**210253: Data Structures & Algorithms**

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

**Prerequisite Courses, if any:**

- Fundamentals of Data Structure
- Basic Mathematics, Geometry, linear algebra, vectors and matrices

**Companion Course, if any:****Course Objectives:**

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

**Course Outcomes:**

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

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

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

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

CO4: To analyze the algorithmic solutions for resource requirements and optimization

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

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

**Course Contents**

Unit I	Hashing	(07 Hours)
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**Hash Table-** Concepts-hash table, hash function, basic operations, bucket, collision, probe, synonym, overflow, open hashing, closed hashing, perfect hash function, load density, full table, load factor, rehashing, issues in hashing, hash functions- properties of good hash function, division, multiplication, extraction, mid-square, folding and universal, Collision resolution strategies- open addressing and chaining, Hash table overflow- open addressing and chaining, extendible hashing, closed addressing and separate chaining.

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

#Exemplar/Case Studies	Book Call Number, Dictionary,
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Mapping of Course Outcomes for Unit I	CO1
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Unit II	Graphs	(08 Hours)
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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.

<b>#Exemplar/Case Studies</b>	Data structure used in Webgraph and Google map			
<b>Mapping of Course Outcomes for Unit II</b>	CO2, CO3			
<b>Unit III</b>	<b>Trees</b>	<b>(07 Hours)</b>		
<b>Tree</b> - 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.				
<b>#Exemplar/Case Studies</b>	Use of binary tree in expression tree-evaluation and Huffman's coding			
<b>Mapping of Course Outcomes for Unit III</b>	CO2, CO3			
<b>Unit IV</b>	<b>Search Trees</b>	<b>(08 Hours)</b>		
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				
<b>#Exemplar/Case Studies</b>	Keyword search in a document using OBST.			
<b>Mapping of Course Outcomes for Unit IV</b>	CO3, CO4			
<b>Unit V</b>	<b>Indexing and Multiway Trees</b>	<b>(06 Hours)</b>		
<b>Indexing and Multiway Trees</b> - 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.				
<b>#Exemplar/Case Studies</b>	Heap as a priority queue			
<b>Mapping of Course Outcomes for Unit V</b>	CO3, CO5			
<b>Unit VI</b>	<b>File Organization</b>	<b>(06 Hours)</b>		
<b>Files</b> : concept, need, primitive operations. <b>Sequential file organization</b> - concept and primitive operations, <b>Direct Access File</b> - Concepts and Primitive operations, <b>Indexed sequential file organization</b> -concept, types of indices, structure of index sequential file, <b>Linked Organization</b> - multi list files, coral rings, inverted files and cellular partitions.				
<b>#Exemplar/Case Studies</b>	<b>External Sort</b> - Consequential processing and merging two lists, multiway merging- a k way merge algorithm			
<b>Mapping of Course Outcomes for Unit VI</b>	CO6			
<b>Learning Resources</b>				
<b>Text Books:</b>				
<ol style="list-style-type: none"> <li>1. Horowitz, Sahani, Dinesh Mehata, —Fundamentals of Data Structures in C++ , Galgotia Publisher, ISBN: 8175152788, 9788175152786.</li> <li>2. M Folk, B Zoellick, G. Riccardi, —File Structures , Pearson Education, ISBN:81-7758-37-5</li> <li>3. Peter Brass, —Advanced Data Structures , Cambridge University Press, ISBN: 978-1-107-43982-5</li> </ol>				

**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 , The McGraw-Hill Companies, ISBN - 9780070667266.
5. Goodrich, Tamassia, Goldwasser, —Data Structures and Algorithms in Java , Wiley Publication, ISBN: 9788126551903

@The CO-PO mapping table

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



**Savitribai Phule Pune University  
Second Year of Engineering (2019 Course)  
210254: Software Engineering**

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

**Prerequisite Courses, if any:** Fundamentals of Programming Languages

**Companion Course, if any:**

**Course Objectives:**

- 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 S/W project development.
- To understand project management through life cycle of the project.

**Course Outcomes:**

- CO1: Apply software engineering principles to develop software.  
 CO2: Analyze software requirements and formulate design solution for a software.  
 CO3: Explain concepts of project estimation, planning and scheduling.  
 CO4: Explain risk management and software configuration management.  
 CO5: Explain various types of software testing.

**Course Contents**

Unit I	Introduction to Software Engineering and Software Process Models	(06 Hours)
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**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	
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Mapping of Course Outcomes for Unit I		
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Unit II	Software Requirements Engineering and Analysis	(06 Hours)
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**Modelling:** 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 ( <a href="http://dos.iitm.ac.in/OOSD_Material/CaseStudies/CaseStudy2/eVote-srs.pdf">http://dos.iitm.ac.in/OOSD_Material/CaseStudies/CaseStudy2/eVote-srs.pdf</a> ), Library management System, Develop use case model for any software applications.
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<b>Mapping of Course Outcomes for Unit II</b>		
<b>Unit III</b>	<b>Estimation and Scheduling</b>	<b>(06 Hours)</b>
<p><b>Estimation for Software Projects:</b> 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 Model, Preparing Requirement Traceability Matrix</p> <p><b>Project Scheduling:</b> Project Scheduling, Defining a Task for the Software Project, Scheduling.</p> <p><b>Suggested Free Open Source Tool:</b> GanttProject, Agantty, ProjectLibre.</p>		
<b>#Exemplar/Case Studies</b>	<p>Write SRS in IEEE format for selected Project Statement/ case study</p> <p>Study SRS of Online Voting system (<a href="http://dos.iitm.ac.in/OOSD_Material/CaseStudies/CaseStudy2/eVote-srs.pdf">http://dos.iitm.ac.in/OOSD_Material/CaseStudies/CaseStudy2/eVote-srs.pdf</a>), Library management System,</p>	
<b>Mapping of Course Outcomes for Unit III</b>		
<b>Unit IV</b>	<b>Design Engineering</b>	<b>(06 Hours)</b>
<p><b>Design Concepts:</b> 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,</p> <p>Design Classes, The Design Model , Data Design Elements, Architectural Design Elements, Interface Design Elements, Component-Level Design Elements, Component Level Design for WebApps, Content Design at the Component Level, Functional Design at the Component Level, Deployment-Level Design Elements,</p> <p><b>Architectural Design:</b> Software Architecture, What is Architecture, Why is Architecture Important, Architectural Styles, A brief Taxonomy of Architectural Styles.</p> <p><b>Suggested Free Open Source Tool:</b> SmartDraw.</p>		
<b>#Exemplar/Case Studies</b>	Study design of Biometric Authentication software	
<b>Mapping of Course Outcomes for Unit IV</b>		
<b>Unit V</b>	<b>Risks and Configuration Management</b>	<b>(06 Hours)</b>
<p><b>Risk Management:</b> Software Risks, Risk Identification, Risk Projection, Risk Refinement, Risk Mitigation, Monitoring, and Management, The RMMM Plan.</p> <p><b>Software Configuration Management:</b> Software Configuration Management, The SCM Repository The SCM Process, Configuration Management for any suitable software system</p> <p>Suggested FreeOpen Source Tools: CFEngine Configuration Tool, Puppet Configuration Tool.</p>		
<b>#Exemplar/Case Studies</b>	Risk management in Food delivery software	
<b>Mapping of Course Outcomes for Unit V</b>		
<b>Unit VI</b>	<b>Software Testing</b>	<b>(06 Hours)</b>

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	
<b>Learning Resources</b>	
<b>Text Books:</b>	
<ol style="list-style-type: none"> <li>1. Roger Pressman, —Software Engineering: A Practitioner's Approach , McGraw Hill, ISBN 0-07-337597-7</li> <li>2. Ian Sommerville, —Software Engineering , Addison and Wesley, ISBN 0-13-703515-2</li> </ol>	
<b>Reference Books:</b>	
<ol style="list-style-type: none"> <li>1. Carlo Ghezzi, —Fundamentals of Software Engineering", Prentice Hall India, ISBN-10: 0133056996</li> <li>2. Rajib Mall, —Fundamentals of Software Engineering , Prentice Hall India, ISBN-13: 978-8120348981</li> <li>3. Pankaj Jalote, —An Integrated Approach to Software Engineering , Springer, ISBN 13: 9788173192715.</li> <li>4. S K Chang, —Handbook of Software Engineering and Knowledge Engineering , World Scientific, Vol I, II, ISBN: 978-981-02-4973-1</li> <li>5. Tom Halt, —Handbook of Software Engineering , Clanye International ISBN-10: 1632402939</li> </ol>	

@The CO-PO mapping table

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



**Savitribai Phule Pune University  
Second Year of Engineering (2019 Course)  
210255: Microprocessor**

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

**Prerequisite Courses, if any:** Digital Electronics and Logic Design

**Companion Course, if any:**

**Course Objectives:**

- To learn the architecture and programmer's model of advanced processor
- To understand the system level features and processes of advanced processor
- To acquaint the learner with application instruction set and logic to build assembly language programs.
- To understand debugging and testing techniques confined to 80386 DX

**Course Outcomes:**

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

CO1: To apply the assembly language programming to develop small real life embedded application.

CO2: To understand the architecture of the advanced processor thoroughly to use the resources for programming

CO3: To understand the higher processor architectures descended from 80386 architecture

**Course Contents**

<b>Unit I</b>	<b>80386DX- Basic Programming Model and Applications Instruction Set</b>	<b>(06 Hours)</b>
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**Memory Organization and Segmentation-** Global Descriptor Table, Local Descriptor Table, Interrupt Descriptor Table, Data Types, Registers, Instruction Format, Operand Selection, Interrupts and Exceptions

**Applications Instruction Set-** Data Movement Instructions, Binary Arithmetic Instructions, Decimal Arithmetic Instructions, Logical Instructions, Control Transfer Instructions, String and Character Transfer Instructions, Instructions for Block Structured Language, Flag Control Instructions, Coprocessor Interface Instructions, Segment Register Instructions, Miscellaneous Instructions.

<b>#Exemplar/Case Studies</b>	
<b>Mapping of Course Outcomes for Unit I</b>	CO1,CO2
<b>Unit II</b>	<b>Systems Architecture and Memory Management</b>

**Systems Architecture-** Systems Registers, Systems Instructions.

**Memory Management-** Segment Translation, Page Translation, Combining Segment and Page Translation.

<b>#Exemplar/Case Studies</b>	
<b>Mapping of Course Outcomes for Unit II</b>	CO3
<b>Unit III</b>	<b>Protection and Multitasking</b>

**Protection-** Need of Protection, Overview of 80386DX Protection Mechanisms, Segment Level Protection, Page Level Protection, Combining Segment and Page Level Protection.

**Multitasking-** Task State Segment, TSS Descriptor, Task Register, Task Gate Descriptor, Task Switching, Task Linking, Task Address Space.

<b>#Exemplar/Case Studies</b>		
<b>Mapping of Course Outcomes for Unit III</b>	CO1,CO2	
<b>Unit IV</b>	<b>Input-Output, Exceptions and Interrupts</b>	<b>(08 Hours)</b>

**Input-Output-** I/O Addressing, I/O Instructions, Protection and I/O

**Exceptions and Interrupts-** Identifying Interrupts, Enabling and Disabling Interrupts, Priority among Simultaneous Interrupts and Exceptions, Interrupt Descriptor Table (IDT), IDT Descriptors, Interrupt Tasks and Interrupt Procedures, Error Code, and Exception Conditions.

<b>#Exemplar/Case Studies</b>		
<b>Mapping of Course Outcomes for Unit IV</b>	CO4	
<b>Unit V</b>	<b>Initialization of 80386DX, Debugging and Virtual 8086 Mode</b>	<b>(08 Hours)</b>

**Initialization-** Processor State after Reset, Software Initialization for Real Address Mode, Switching to Protected Mode, Software Initialization for Protected Mode, Initialization Example, TLB Testing

**Debugging-** Debugging Features of the Architecture, Debug Registers, Debug Exceptions, Breakpoint Exception

**Virtual 8086 Mode-** Executing 8086 Code, Structure of V86 Stack, Entering and Leaving Virtual 8086 Mode.

<b>#Exemplar/Case Studies</b>		
<b>Mapping of Course Outcomes for Unit V</b>	CO4	
<b>Unit VI</b>	<b>80387 Coprocessor and Introduction to Microcontrollers</b>	<b>(06 Hours)</b>

**80387 NDP-** Control Register bits for Coprocessor support, 80387 Register Stack, Data Types, Load and Store Instructions, Trigonometric and Transcendental Instructions, Interfacing signals of 80386DX with 80387.

Introduction to Microcontrollers: Architecture of typical Microcontroller, Difference between Microprocessor and Microcontroller, Characteristics of 8 bit and 16 bit microcontrollers, Application of Microcontrollers

<b>#Exemplar/Case Studies</b>		
<b>Mapping of Course Outcomes for Unit VI</b>	CO4	

## Learning Resources

### Text Books:

1. A.Ray, K.Bhurchandi, "Advanced Microprocessors and peripherals: Arch, Programming & Interfacing", Tata McGraw Hill,2004 ISBN 0-07-463841-6
2. Intel 80386 Programmer's Reference Manual 1986, Intel Corporation, Order no.: 231630-011, December 1995.
3. James Turley, "Advanced 80386 Programming Techniques", McGraw-Hill, ISBN: 10: 0078813425, 13: 978-0078813429.

**Reference Books:**

1. Chris H. Pappas, William H. Murray, —80386 Microprocessor Handbooks , McGraw-Hill Osborne Media, ISBN-10: 0078812429, 13: 978-0078812422.
2. Douglas Hall, "Microprocessors & Interfacing", McGraw Hill, Revised 2 Edition, 2006 ISBN 0-07-100462-9
3. Intel 387DX Math coprocessor, Order no.: 240448-005, March1992.
4. Walter A. Triebel, —The 80386Dx Microprocessor: Hardware , Software, and Interfacing, Pearson Education, ISBN: 0137877307, 9780137877300.
5. Brey, Barry B, —8086/8088, 80286, 80386 and 80486 Assembly Language Programming , Prentice Hall, ISBN: 13: 9780023142475.
6. Mohammad Rafiquzzaman, —Microprocessors: Theory and Applications: Intel and Motorola", Prentice Hall, ISBN:-10:0966498011, 13:978:0966498011.
7. Introduction to 64 bit Intel Assembly Language Programming for Linux, 2nd Edition, Ray Seyfarth, ISBN10: 1478119209, ISBN-13: 9781478119203, 2012.
8. Assembly Language Step-by-step: Programming with Linux, 3rd Edition, Jeff Duntemann, Wiley ISBN:-10 0470497025, ISBN-13: 978-0470497029, 2009.

@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	2	2	-
CO2	2	2	2	2	-	-	-	-	2	2	-	-
CO3	2	2	1	1	-	-	-	-	2	1	-	-
CO4	2	2	2	2	-	-	-	-	2	2	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	-	-	-	-



<b>Savitribai Phule Pune University</b> <b>Second Year of Engineering (2019 Course)</b> <b>210256: Principles of Programming Languages</b>		
<b>Teaching Scheme:</b>	<b>Credit</b>	<b>Examination Scheme:</b>
<b>TH: 03 Hours/Week</b>	<b>03</b>	<b>Mid_Semester(TH): 30 Marks</b> <b>End_Semester(TH): 70 Marks</b>
<b>Prerequisite Courses, if any:</b> Fundamentals of Data Structures, Object Oriented Programming, Fundamentals of programming language.		
<b>Companion Course, if any:</b> Software Engineering, Data Structures and Algorithms, Project based learning		
<b>Course Objectives:</b> <ul style="list-style-type: none"> <li>• To learn basic principles of programming languages and programming paradigms</li> <li>• To learn structuring the data and manipulation of data, computation and program structure</li> <li>• To learn Object Oriented Programming (OOP) principles using Java Programming Language</li> <li>• To learn basic concepts of logical and functional programming language</li> </ul>		
<b>Course Outcomes:</b> On completion of the course, student will be able to– CO1: Make use of basic principles of programming languages CO2: Able to develop a program with Data representation and Computations CO3: Able to develop programs using Object Oriented Programming language : Java CO4: Develop application using inheritance, encapsulation, and polymorphism CO5: Able to demonstrate Applet and Multithreading for robust application development CO6: Able to develop a simple program using basic concepts of Functional and Logical programming paradigm		
<b>Course Contents</b>		
<b>Unit I</b>	<b>Fundamentals of Programming</b>	<b>(06 Hours)</b>
Importance of Studying Programming Languages, History of Programming Languages, Impact of Programming Paradigms, Role of Programming Languages, Programming Environments. Impact of Machine Architectures: The operation of a computer, Virtual Computers and Binding Times. <b>Programming paradigms-</b> Introduction to programming paradigms, Introduction to four main Programming paradigms- procedural, object oriented, functional, and logic & rule based.		
<b>#Exemplar/Case Studies</b>	A case study: Retail Sales application	
<b>Mapping of Course Outcomes for Unit I</b>	CO1	
<b>Unit II</b>	<b>Structuring the Data, Computations and Program</b>	<b>(06 Hours)</b>
<b>Elementary Data Types :</b> Primitive data Types, Character String types, User Defined Ordinal Types, Array types, Associative Arrays, Record Types, Union Types, Pointer and reference Type. <b>Expression and Assignment Statements:</b> Arithmetic expression, Overloaded Operators, Type conversions, Relational and Boolean Expressions, Short Circuit Evaluation, Assignment Statements, Mixed mode Assignment. <b>Statement level Control Statements:</b> Selection Statements, Iterative Statements, Unconditional Branching. <b>Subprograms:</b> Fundamentals of Sub Programs, Design Issues for Subprograms, Local referencing Environments, Parameter passing methods. <b>Abstract Data Types and Encapsulation Construct:</b> Design issues for Abstraction, Parameterized Abstract Data types, Encapsulation Constructs, Naming Encapsulations		

#Exemplar/Case Studies	Data representation and computations in Retail Sales	
Mapping of Course Outcomes for Unit II	CO2	
Unit III	<b>Java as Object Oriented Programming Language- Overview</b>	<b>(06 Hours)</b>
<b>Fundamentals of JAVA, Arrays:</b> one dimensional array, multi-dimensional array, alternative array declaration statements , <b>String Handling:</b> String class methods, <b>Classes and Methods:</b> class fundamentals, declaring objects, assigning object reference variables, adding methods to a class, returning a value, constructors, this keyword, garbage collection, finalize() method, overloading methods, argument passing, object as parameter, returning objects, access control, static, final, nested and inner classes, command line arguments, variable -length arguments.		
#Exemplar/Case Studies	Demonstrate classes , objects, data, methods for Online Banking System using Java	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	<b>Inheritance, Packages and Exception Handling using Java</b>	<b>(06 Hours)</b>
<b>Inheritances:</b> member access and inheritance, super class references, Using super, multilevel hierarchy, constructor call sequence, method overriding, dynamic method dispatch, abstract classes, Object class. <b>Packages and Interfaces:</b> defining a package, finding packages and CLASSPATH, access protection, importing packages, interfaces (defining, implementation, nesting, applying), variables in interfaces, extending interfaces, instance of operator. fundamental, exception types, uncaught exceptions, try, catch, throw, throws, finally, multiple catch clauses, nested try statements, built-in exceptions, custom exceptions (creating your own exception sub classes). <b>Managing I/O:</b> Streams, Byte Streams and Character Streams, Predefined Streams, Reading console Input, Writing Console Output, Print Writer class.		
#Exemplar/Case Studies	Demonstrate inheritance, Packages and interface forOnline Banking System using Java	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	<b>Multithreading in Java</b>	<b>(06 Hours)</b>
<b>Concurrency and Synchronization, Java Thread Model:</b> Thread priorities, Synchronization, Messaging, Main Thread, Creating thread: Implementing Thread using thread class and Runnable interface. Creating multiple threads using isAlive() and join()		
<b>Web Based Application in Java:</b> Use of JavaScript for creating web based applications in java, Introduction to javascript frameworks- React, Vue, Angular		
#Exemplar/Case Studies	Demonstrate Multithreading for Gaming	
Mapping of Course Outcomes for Unit V	CO5	
Unit VI	<b>Logical and Functional Programming</b>	<b>(06 Hours)</b>
<b>Functional Programming Paradigm:</b> Understanding symbol manipulation, Basic LISP functions, definitions, predicates, conditionals and scoping, Recursion and iteration, Properties List array and access functions, Using lambda definitions, printing, reading and atom manipulation. <b>Logic Programming Paradigm:</b> An Overview of Prolog, Syntax and Meaning of Prolog Programs, Lists, Operators, Arithmetic, Using Structures: Example Programs		
#Exemplar/Case Studies	Demonstrate Functional and Logic Programming for Software Project Management.	
Mapping of Course Outcomes for Unit VI	CO6	

## Learning Resources

### Text Books:

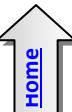
1. T. W. Pratt, M. V. Zelkowitz, "Programming Languages Design and Implementation , 4<sup>th</sup> Ed, PHI, ISBN 81-203-2035-2.
2. Sebesta R., "Concepts of Programming Languages", 4th Edition, Pearson Education, ISBN-81-7808-161-X.
3. Herbert Schildt, "The Complete Reference Java", 9th Ed, TMH,ISBN: 978-0-07-180856-9.

### Reference Books:

1. Dr.R. Nageshwar Rao, "Core Java: An Integrated Approach", Dreamtech Press
2. Deugo, —Java Gems , Cambridge University Press, ISBN 10: 0521648246 ISBN 13: 9780521648240
3. Carl Townsend , "Programming in turbo PROLOG", Tata-McGraw Hill
4. Ivan Bratko, " Prolog Programming for Artificial Intelligence", Wesley Publishers Limited
5. Winston P., Klaus B., Horn P., "LISP", 3rd Edition, Pearson Education, 81 - 7808 -155-5
6. Carlo Ghezzi, Mehdi Jazayeri, —Programming Language Concepts ,3rd Ed, Wiley Publication ISBN : 978-81-265-1861-6.

@The CO-PO mapping table

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CO1	3	2	2	2	2	1	-	1	2	-	1	3
CO2	3	3	3	3	2	1	-	1	2	1	3	3
CO3	3	3	3	3	3	2	1	3	2	1	3	3
CO4	3	3	3	3	3	2	1	3	2	1	3	3
CO5	3	3	3	3	3	2	1	3	2	1	3	3
CO6	3	3	3	3	3	2	1	3	2	1	3	3



**Savitribai Phule Pune University  
Second Year of Computer Engineering (2019 Course)  
210257: Data Structures & Algorithms Laboratory**

<b>Teaching Scheme:</b> <b>PR: 04 Hours/Week</b>	<b>Credit</b> <b>02</b>	<b>Examination Scheme:</b> <b>TW: 25 Marks</b> <b>PR: 50 Marks</b>
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**Guidelines for Instructor's Manual**

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

**Guidelines for Student's Laboratory Journal**

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

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

**Guidelines for Laboratory Conduction**

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

In addition to these, instructor may assign one real life application in the form of a mini-project based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

Set of suggested assignment list is provided in groups- A, B, C, D, E, F and G. Each student must perform at least 12 assignments as 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

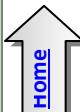
**Programming tools recommended:** - Open Source Python - Group A assignments, C++ Programming tool like G++/GCC

**Suggested List of Laboratory Experiments/Assignments**

Sr. No.	<b>Group A</b>
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 (newElement) -Place a value into the set b. Remove (element) Remove the value c. Contains (element) Return true if element is in collection d. Size () Return number of values in collection e. Iterator () Return an iterator used to loop over collection f. Intersection of two sets g. Union of two sets h. Difference between two sets
<b>Group B</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 postorder 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 & 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.
	<b>Group C</b>
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 $t_1, \dots, t_n$ 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.)
	<b>Group D</b>
18	Given sequence $k = k_1 < k_2 < \dots < k_n$ 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 & 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
	<b>Group E</b>
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.

<b>Group F</b>	
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.
<b>Mini-Projects/ Case Study</b>	
27	Design a mini project using JAVA which will use the different data structure with or without Java collection library and show the use of specific data structure on the efficiency (performance) of the code.
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.



**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210258: Microprocessor Laboratory**

<b>Teaching Scheme:</b> <b>PR: 04 Hours/Week</b>	<b>Credit</b> <b>02</b>	<b>Examination Scheme:</b> <b>TW: 25 Marks</b> <b>PR: 50 Marks</b>
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**Guidelines for Instructor's Manual**

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

**Guidelines for Student's Laboratory Journal**

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and 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, instructions/features used, test cases, conclusion/analysis and references).

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 /TW Assessment**

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

**Guidelines for Laboratory Conduction**

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

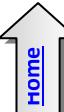
**Operating System:** Latest 64-bit Version and update of Microsoft Windows 7/ Windows 8 Operating System onwards or 64-bit Open source Linux or its derivative.

**Programming Tools:** Preferably using Linux equivalent or MASM 64x or equivalent, Microsoft Visual Studio x64 Intrinsic.

**Suggested List of Laboratory Experiments/Assignments**

<b>Sr. No.</b>	<b>Assignments</b>
1	Write X86/64 ALP to count number of positive and negative numbers from the array.

2	Write an ALP to accept five 64 bit Hexadecimal numbers from user and store them in an array and display the accepted numbers.
3	Write X86/64 ALP to perform non-overlapped block transfer (with and without string specific instructions). Block containing data can be defined in the data segment.
4	Write X86/64 ALP to perform overlapped block transfer (with and without string specific instructions). Block containing data can be defined in the data segment.
5	Write X86/64 ALP to perform multiplication of two 8-bit hexadecimal numbers. Use successive addition and add and shift method. (use of 64-bit registers is expected).
6	Write X86/64 ALP to convert 4-digit Hex number into its equivalent BCD number and 5-digit BCD number into its equivalent HEX number. Make your program user friendly to accept the choice from user for: (a) HEX to BCD b) BCD to HEX (c) EXIT. Display proper strings to prompt the user while accepting the input and displaying the result. (wherever necessary, use 64-bit registers).
7	Write X86 Assembly Language Program (ALP) to implement following OS commands i. TYPE ii. COPY and iii. DELETE Using file operations. User is supposed to provide command line arguments in all cases.
8	Write X86 ALP to find, a) Number of Blank spaces b) Number of lines c) Occurrence of a particular character. Accept the data from the text file. The text file has to be accessed during Program_1 execution and write FAR PROCEDURES in Program_2 for the rest of the processing. Use of PUBLIC and EXTERN directives is mandatory.
9	Write X86 program to sort the list of integers in ascending/descending order. Read the input from the text file and write the sorted data back to the same text file using bubble sort.
10	Write X86/64 ALP to switch from real mode to protected mode and display the values of GDTR, LDTR, IDTR, TR and MSW Registers also identify CPU type using CPUID instruction.
11	Write x86 ALP to find the factorial of a given integer number on a command line by using recursion. Explicit stack manipulation is expected in the code.
12	Write 80387 ALP to obtain: i) Mean ii) Variance iii) Standard Deviation. Define the input values in data segment.
13	Write 80387 ALP to find the roots of the quadratic equation. All the possible cases must be considered in calculating the roots.
14	Write an ALP password program that operates as follows: a. Do not display what is actually typed instead display asterisk ("*"). If the password is correct display, "access is granted" else display "Access not Granted"



**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210259: Code of Conduct**

Teaching Scheme:	Credit	Examination Scheme:
TUT: 01 Hours/Week	00	---

**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 & 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. Engineering 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. 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. 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. 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

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

**#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 ant 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.

**Learning Resources****Books:**

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York (2005).
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics –Concepts and Cases", Thompson Learning, (2000).
3. Charles D Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, (1999).
4. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, (2003)
5. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, (2001)
6. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, "Business Ethics – An Indian Perspective", Biztantra, New Delhi, (2004)

David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, (2003)

**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](http://www.ewh.ieee.org/soc/pes/switchgear/presentations/tp_files/2017-1_Thurs_Shiffbauer_Singer_Engineering_Ethics.pdf)

**MOOC:**

**@The CO-PO mapping table**

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



**Savitribai Phule Pune University**  
**Second Year of Computer Engineering (2019 Course)**  
**210260: Project Based Learning**

Teaching Scheme:	Credit	Examination Scheme:
PR: 04 Hours/Week	02	TW: 50 Marks

**Prerequisite Courses, if any:** Problem Based Learning.

**Companion Course, if any:** Software Engineering.

**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 this may promote entrepreneurship and research culture among the students.

**Course Outcomes:**

CO1: Ability to solve real life problems by applying knowledge.

CO2: Ability to analyze alternative approaches, apply and use most appropriate one for feasible solution.

CO3: Ability to understand basics of IT Project management

CO4: Students should be able to accept and meet challenges in the real world, mirroring what professionals do every day.

CO5: Able to Classify software applications and identify unique features of various domains

CO6: Learning by doing approach in PBL will promote long-term retention of material and replicable skill, as well as improve teachers' and students' attitudes towards learning.

**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.

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 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 &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 & 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.

**Note: @The CO-PO mapping table will be according to project assignment**

#### **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 RobartCapraro, Mary MargaretCapraro

**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. Project management core text book, 2 Indian Edition , by Gopalan.
3. The Art of Agile Development. By James Shore & Shane Warden.

**Following Fields are applicable for Tutorial of Project Based Learning****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 student 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 defined
- 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 metacognitive 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 learning 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 thoughtout 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 interpersonal skills.
- Consensual decision making skills
- Dialogue and discussion skills

- Team maintenance skills
- Conflict management skills
- Team leadership skills.

Students who have these skills have a better opportunity to learn than students who do not have these skills.

- Time Management

#### **Resources**

- Students need to have the ability to evaluate the resources used
- Students have to be able 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?

#### **Metacognitive Skills**

- Students need to reflect on the processes they are using during the learning process,
- To compare one strategy with another, and
- To 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?



**Savitribai Phule Pune University**  
**Second Year of Engineering (2019 Course)**  
**210261:Audit Course 4**

In addition to credits, it is recommended that there should be audit course in preferably in each semester from second year. Student will be awarded the bachelor's degree if he/she earns 190 credits 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 in-semester 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):**

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

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

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

**Audit Course 4 Options**

<b>Audit Course</b>	<b>Audit Course Title</b>
<b>Code</b>	
<b>AC4-I</b>	Water Management
<b>AC4-II</b>	Intellectual Property Rights and Patents
<b>AC4-III</b>	The Science of Happiness
<b>AC4-IV</b>	Stress Relief: Yoga and Meditation
<b>AC4-V</b>	Foreign Language (one of Japanese/Spanish/French/German) Course contents for <b>Japanese( Module 2)</b> are provided. For other languages institute may design suitably.

## AC4-I: Water Management

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

### **Course Objectives**

- To develop understanding of water resources.
- 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 resources.

### **Course Outcomes**

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

1. Understanding of the global water cycle and its various processes
2. Understanding of climate change and their effects on water systems
3. Understanding of Drinking treatment and quality of groundwater and surface water
4. Understanding of 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.

## AC4-II: Intellectual Property Rights and Patents

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

Innovation and originality have great potential value. Whatever line of activity you are engaged in, future success depends on them. The last few years have seen intellectual property rights become an issue of general interest: the smart phone “patent wars”, the introduction of Digital Rights management (DRM) and the rise of generic pharmaceuticals and open-source software are just some examples that have been in the public eye. Protecting your intellectual rights appropriately should be a top 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—

1. Understand the fundamental legal principles related to confidential information, copyright, patents, designs, trademarks and unfair competition
2. Identify, apply and assess principles of law relating to each of these areas of intellectual property
3. 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 IPR 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 partes Proceeding – Infringement - Dilution Ownership of Trade mark
3. **Introduction to Copyrights** – Principles of Copyright Principles -The subjects Matter of Copy right – The Rights Afforded by Copyright Law – Copy right Ownership, Transfer and duration – Right to prepare Derivative works
4. **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 & 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

### AC4-III: The Science of Happiness

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

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

#### **Course Objectives**

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

#### **Course Outcomes**

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

1. Ability to understand what happiness is and why it matters to you
2. Ability to learn how to increase your own happiness
3. Understanding of the power of social connections and the science of empathy
4. Ability to 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 Well being
7. Subjective well being
8. Love and well being
9. Optimal well being
10. Religion, Spirituality and well being

#### **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.

## AC4-IV: Yoga and Meditation

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

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

### **Course Objectives**

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

### **Course Outcomes:-**

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

1. Students understanding of philosophy and religion as well as daily life issues will be challenged and enhanced.
2. Enhances the immune system.
3. Intellectual and philosophical understanding of the theory of yoga and basic related Hindu scriptures will be developed.
4. 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

## AC4-V: Foreign Language ( Japanese) Module 2

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

### **Course Objectives:**

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

### **Course Outcomes:**

On completion of the course student

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

### **Course Contents**

1. Katakana basic Script, Denoting things ( nominal & prenominal demonstratives ), Purchasing at the Market / in a shop / mall (asking & stating price)
2. Katakana : Modified kana, double consonant, letters with ya, yu, yo, Long vowels, Describing time, describing starting & 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 & 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](http://www.tcs.com/news_events/press_releases/Pages/TCS-Inaugurates-Japan-centric-Delivery-Center-Pune.aspx))

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



<http://unipune.ac.in>

**Curriculum  
for  
Third Year of Computer Engineering  
(2019 Course)  
(With effect from 2021-22)**

# Prologue

It is with great pleasure and honor that I share the syllabi for Third Year of Computer Engineering (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**

**Savitribai Phule Pune University**  
**Third Year of Computer Engineering (2019 Course)**  
(With effect from Academic Year 2021-22)

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<b>Savitribai Phule Pune University</b> <b>Bachelor of Computer Engineering</b>		
<b>Program Outcomes (POs)</b>		
<b>Learners are expected to know and be able to</b>		
<b>PO1</b>	<b>Engineering knowledge</b>	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems.
<b>PO2</b>	<b>Problem analysis</b>	Identify, formulate, review research literature and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and Engineering sciences.
<b>PO3</b>	<b>Design / Development of Solutions</b>	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.
<b>PO4</b>	<b>Conduct Investigations of Complex Problems</b>	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.
<b>PO5</b>	<b>Modern Tool Usage</b>	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.
<b>PO6</b>	<b>The Engineer and Society</b>	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.
<b>PO7</b>	<b>Environment and Sustainability</b>	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
<b>PO8</b>	<b>Ethics</b>	Apply ethical principles and commit to professional ethics and responsibilities and norms of Engineering practice.
<b>PO9</b>	<b>Individual and Team Work</b>	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
<b>PO10</b>	<b>Communication Skills</b>	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.
<b>PO11</b>	<b>Project Management and Finance</b>	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.
<b>PO12</b>	<b>Life-long Learning</b>	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.
<b>Program Specific Outcomes (PSO)</b>		
<b>A graduate of the Computer Engineering Program will demonstrate-</b>		
<b>PSO1</b>	<b>Professional Skills</b> -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.	
<b>PSO2</b>	<b>Problem-Solving Skills</b> - 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.	
<b>PSO3</b>	<b>Successful Career and Entrepreneurship</b> - 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 Computer Engineering (2019 Course) (With effect from Academic Year 2021-22)														
Semester V														
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
310241	<a href="#">Database Management Systems</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
310242	<a href="#">Theory of Computation</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
310243	<a href="#">Systems Programming and Operating System</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
310244	<a href="#">Computer Networks and Security</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
310245	<a href="#">Elective I</a>	03	-	-	30	70	-	-	-	100	03	-	-	03
310246	<a href="#">Database Management Systems Laboratory</a>	-	04	-	-	-	25	25	-	50	-	02	-	02
310247	<a href="#">Computer Networks and Security Laboratory</a>	-	02	-	-	-	25	-	25	50	-	01	-	01
310248	<a href="#">Laboratory Practice I</a>	-	04	-	-	-	25	25	-	50	-	02	-	02
310249	<a href="#">Seminar and Technical Communication</a>	-	01	-	-	-	50	-	-	50	-	01	-	01
<b>Total</b>		<b>15</b>	<b>11</b>	<b>-</b>	<b>150</b>	<b>350</b>	<b>125</b>	<b>50</b>	<b>25</b>	<b>700</b>	<b>15</b>	<b>06</b>	<b>-</b>	<b>21</b>
310250	<a href="#">Audit Course 5</a>												<b>Grade</b>	
														<b>Total Credit</b> <b>15</b> <b>06</b> <b>-</b> <b>21</b>
<b>Elective I</b> <ul style="list-style-type: none"> <li>• <a href="#">Internet of Things and Embedded Systems</a></li> <li>• <a href="#">Human Computer Interface</a></li> <li>• <a href="#">Distributed Systems</a></li> <li>• <a href="#">Software Project Management</a></li> </ul>							<b>Audit Course 5</b> <ul style="list-style-type: none"> <li>• Cyber Security</li> <li>• Professional Ethics and Etiquettes</li> <li>• MOOC- Learn New Skills</li> <li>• Engineering Economics</li> <li>• Foreign Language</li> </ul>							
<b>Laboratory Practice I</b> Assignments from <b>Systems Programming and Operating System</b> and <b>Elective I</b>														

Savitribai Phule Pune University Third Year of Computer Engineering (2019 Course) (With effect from Academic Year 2021-22)																							
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	Total									
310251	<a href="#">Data Science and Big Data Analytics</a>	03	-	-	30	70	-	-	-	100	03	-	-	03									
310252	<a href="#">Web Technology</a>	03	-	-	30	70	-	-	-	100	03	-	-	03									
310253	<a href="#">Artificial Intelligence</a>	03	-	-	30	70	-	-	-	100	03	-	-	03									
310254	<a href="#">Elective II</a>	03	-	-	30	70	-	-	-	100	03	-	-	03									
310255	<a href="#">Internship**</a>	-	**	-	-	-	100 **	-	-	100	-	04 **	-	04									
310256	<a href="#">Data Science and Big Data Analytics Laboratory</a>	-	04	-	-	-	50	25	-	75	-	02	-	02									
310257	<a href="#">Web Technology Laboratory</a>	-	02	-	-	-	25	-	25	50	-	01	-	01									
310258	<a href="#">Laboratory Practice II</a>	-	04	-	-	-	50	25	-	75	-	02	-	02									
											<b>Total</b>	<b>12</b>	<b>09</b>	<b>-</b>	<b>21</b>								
		<b>Total</b>	<b>12</b>	<b>10</b>	<b>-</b>	<b>120</b>	<b>280</b>	<b>225</b>	<b>50</b>	<b>25</b>	<b>700</b>	<b>12</b>	<b>05</b>	<b>-</b>	<b>21</b>								
310259	<a href="#">Audit Course 6</a>													<b>Grade</b>									
<b>Elective II</b>						<b>Audit Course 6</b>																	
<ul style="list-style-type: none"> <li><a href="#">Information Security</a></li> <li><a href="#">Augmented and Virtual Reality</a></li> <li><a href="#">Cloud Computing</a></li> <li><a href="#">Software Modeling and Architectures</a></li> </ul>						<ul style="list-style-type: none"> <li>Digital and Social Media Marketing</li> <li>Sustainable Energy Systems</li> <li>Leadership and Personality Development</li> <li>Foreign Language</li> <li>MOOC- Learn New Skills</li> </ul>																	
<b>Laboratory Practice II:</b> Assignments from Artificial Intelligence and Elective II.																							
<b>** Internship:</b> Internship guidelines are provided in course curriculum sheet.																							

## 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 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 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<sup>[1]</sup>. 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]

**Note:** For more rules, pattern and assessment of semester examination refer [1]

[1][http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/Rules%20and%20Regulations%20F.E.%202019%20Patt\\_10.012020.pdf](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>

<b>Abbreviations</b>		
<b>TW: Term Work</b>	<b>TH: Theory</b>	<b>PR: Practical</b>
<b>OR: Oral</b>	<b>TUT: Tutorial</b>	<b>Sem: Semester</b>

# Semester V

**Savitribai Phule Pune University**  
**Third Year of Computer Engineering (2019 Course)**  
**310241: Database Management Systems**

**Teaching Scheme:**  
**TH: 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:** Database Management Systems Laboratory (310246)

**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**

<b>Unit I</b>	<b>Introduction to Database Management Systems and ER Model</b>	<b>06 Hours</b>
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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.

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

<b>Unit II</b>	<b>SQL and PL/SQL</b>	<b>07 Hours</b>
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**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.

<b>#Exemplar/Case Studies</b>	Implementation of Unit 1 case study using SQL and PL/SQL.
<b>*Mapping of Course Outcomes for Unit II</b>	CO1, CO2

<b>Unit III</b>	<b>Relational Database Design</b>	<b>06 Hours</b>
<b>Relational Model:</b> Basic concepts, Attributes and Domains, CODD's Rules. <b>Relational Integrity:</b> Domain, Referential Integrities, Enterprise Constraints. <b>Database Design:</b> Features of Good Relational Designs, Normalization, Atomic Domains and First Normal Form, Decomposition using Functional Dependencies, Algorithms for Decomposition, 2NF, 3NF, BCNF.		
<b>#Exemplar/Case Studies</b>	Normalize relational database designed in Unit I.	
<b>*Mapping of Course Outcomes for Unit III</b>	CO1, CO3	
<b>Unit IV</b>	<b>Database Transaction Management</b>	<b>07 Hours</b>
Introduction to Database Transaction, Transaction states, ACID properties, Concept of Schedule, Serial Schedule. <b>Serializability:</b> Conflict and View, Cascaded Aborts, Recoverable and Non-recoverable Schedules. <b>Concurrency Control:</b> Lock-based, Time-stamp based Deadlock handling. <b>Recovery methods:</b> Shadow-Paging and Log-Based Recovery, Checkpoints. <b>Log-Based Recovery:</b> Deferred Database Modifications and Immediate Database Modifications.		
<b>#Exemplar/Case Studies</b>	Study of Transaction Management in PostgreSQL	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO3, CO4	
<b>Unit V</b>	<b>NoSQL Databases</b>	<b>07 Hours</b>
Introduction to Distributed Database System, Advantages, disadvantages, CAP Theorem. <b>Types of Data:</b> Structured, Unstructured Data and Semi-Structured Data. <b>NoSQL Database:</b> Introduction, Need, Features. <b>Types of NoSQL Databases:</b> Key-value store, document store, graph, wide column stores, BASE Properties, Data Consistency model, ACID Vs BASE, Comparative study of RDBMS and NoSQL. <b>MongoDB</b> (with syntax and usage): CRUD Operations, Indexing, Aggregation, MapReduce, Replication, Sharding.		
<b>#Exemplar/Case Studies</b>	Use of NoSQL databases for processing unstructured data from social media.	
<b>*Mapping of Course Outcomes for Unit V</b>	CO5, CO6	
<b>Unit VI</b>	<b>Advances in Databases</b>	<b>07 Hours</b>
<b>Emerging Databases:</b> Active and Deductive Databases, Main Memory Databases, Semantic Databases. <b>Complex Data Types:</b> Semi-Structured Data, Features of Semi-Structured Data Models. <b>Nested Data Types:</b> JSON, XML. <b>Object Orientation:</b> Object-Relational Database System, Table Inheritance, Object-Relational Mapping. <b>Spatial Data:</b> Geographic Data, Geometric Data.		
<b>#Exemplar/Case Studies</b>	Applications of advanced databases in real time environment.	
<b>*Mapping of Course Outcomes for Unit VI</b>	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

**e-Books :**

- SQL and Relational Theory  
(How to Write Accurate SQL code), C.J. Date, O'REILLY Publication
- 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

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

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****310242: Theory of Computation** Home**Teaching Scheme:****TH: 03****Hours/Week****Credit: 03****Examination Scheme:****Mid-Sem (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:** Discrete Mathematics (210241)**Companion Course:** --**Course Objectives:**

- To introduce the students to basics of Theory of Computation
- To study abstract computing models to provide a formal connection between algorithmic problem solving and the theory of languages
- To learn Grammar, Pushdown Automata and Turing Machine for language processing and algorithm design
- To learn about the theory of computability and complexity for algorithm design

**Course Outcomes:**

After completion of the course, learners should be able to

**CO1:** Understand formal language, translation logic, essentials of translation, alphabets, language representation and apply it to design Finite Automata and its variants

**CO2:** Construct regular expression to present regular language and understand pumping lemma for RE

**CO3:** Design Context Free Grammars and learn to simplify the grammar

**CO4:** Construct Pushdown Automaton model for the Context Free Language

**CO5:** Design Turing Machine for the different requirements outlined by theoretical computer science

**CO6:** Understand different classes of problems, classify and analyze them and study concepts of NP completeness

**Course Contents**

<b>Unit I</b>	<b>Formal Language Theory and Finite Automata</b>	<b>07 Hours</b>
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**Finite Automata (FA):** An informal picture of FA, Finite State Machine (FSM), Language accepted by FA, Definition of Regular Language.

**FA without output:** Deterministic and Nondeterministic FA (DFA and NFA), epsilon- NFA and inter-conversion. Minimization of DFAs.

**FA with output:** Moore and Mealy machines -Definition, models, inter-conversion.

<b>#Exemplar/Case Studies</b>	FSM for vending machine, spell checker
<b>*Mapping of Course Outcomes for Unit I</b>	CO1

**Unit II                    Regular Expressions (RE)                    07 Hours**

Introduction, Operators of RE, Precedence of operators, Algebraic laws for RE, Language to Regular Expressions, Equivalence of two REs. **Conversions:** RE to NFA, DFA, DFA to RE using Arden's theorem, Pumping Lemma for Regular languages, Closure and Decision properties of Regular languages. Myhill-Nerode theorem.

#Exemplar/Case Studies	RE in text search and replace	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III	<b>Context Free Grammar (CFG) and Context Free Language (CFL)</b>	<b>07 Hours</b>
Basic Elements of Grammar, Formal Definition of Context Free Grammar, Sentential form, Derivation and Derivation Tree/ Parse Tree, Context Free Language (CFL), Ambiguous Grammar, writing grammar for language. <b>Simplification of CFG:</b> Eliminating $\epsilon$ -productions, unit productions, useless production, useless symbols. <b>Normal Forms:</b> Chomsky Normal Form, Greibach Normal Form, Pumping Lemma for CFG, Closure properties of CFL, Decision properties of CFL, Chomsky Hierarchy, Cock-Younger-Kasami Algorithm.		
#Exemplar/Case Studies	Parser, CFG for Palindromes, Parenthesis Match	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	<b>Pushdown Automata (PDA)</b>	<b>07 Hours</b>
Introduction, Formal definition of PDA, Equivalence of Acceptance by Final State and Empty stack, Non-deterministic PDA (NPDA), PDA and Context Free Language, Equivalence of PDA and CFG, PDA vs CFLs. Deterministic CFLs.		
#Exemplar/Case Studies	Parsing and PDA: Top-Down Parsing, Bottom-up Parsing simulation showing use of PDA	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	<b>Turing Machines (TM)</b>	<b>07 Hours</b>
Turing Machine Model, Formal definition of Turing Machines, Language Acceptability by Turing Machines, Design of TM, Description of TM, Techniques for TM Construction, Computing function with Turing Machine, Variants of Turing Machines, Halting Problem of TM, Halting vs Looping, A Turing-unrecognizable language, Reducibility, Recursion Theorem. The Model of Linear Bounded Automata.		
#Exemplar/Case Studies	Algorithms using Turing Machine	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	<b>Computability and Complexity Theory</b>	<b>07 Hours</b>
<b>Computability Theory:</b> Decidable Problems and Un-decidable Problems, Church-Turing Thesis. <b>Reducibility:</b> Undecidable Problems that is recursively enumerable, A Simple Un-decidable. <b>Complexity Classes:</b> Time and Space Measures, The Class P, Examples of problems in P, The Class NP, Examples of problems in NP, P Problem Versus NP Problem, NP-completeness and hard Problems.		
#Exemplar/Case Studies	Traveling salesman problem, Post Correspondence Problem (PCP)	
*Mapping of Course Outcomes for Unit VI	CO6	

## Learning Resources

**Text Books:**

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D.Ullman, "Introduction to Automata Theory Languages and Computation", Addison-Wesley, ISBN 0-201-44124-1
2. John Martin, "Introduction to Languages and The Theory of Computation", 2nd Edition, McGrawHill Education, ISBN-13: 978-1-25-900558-9, ISBN-10: 1-25-900558-5

**Reference Books:**

1. Sanjeev Arora and Boaz Barak, "Computational Complexity: A Modern Approach", Cambridge University Press, ISBN: 0521424267 97805214242643.
2. Daniel Cohen, "Introduction to Computer Theory", Wiley & Sons, ISBN 97881265133454.
3. J. Carroll & D Long, "Theory of Finite Automata", Prentice Hall, ISBN 0-13-913708-45.
4. Kavi Mahesh, "Theory of Computation: A Problem-Solving Approach", Wiley India, ISBN1081265331106.
5. Michael Sipser, "Introduction to the Theory of Computation", Cengage Learning, ISBN-13: 97811331878137.
6. Vivek Kulkarni, "Theory of Computation", Oxford University Press, ISBN 0-19-808458

**e-Books :**

- <https://cglab.ca/~michiel/TheoryOfComputation/TheoryOfComputation.pdf>
- [https://www.cs.virginia.edu/~robins/Sipser\\_2006\\_Second\\_Edition\\_Problems.pdf](https://www.cs.virginia.edu/~robins/Sipser_2006_Second_Edition_Problems.pdf)
- [http://ce.sharif.edu/courses/94-95/1/ce414-2/resources/root/Text%20Books/Automata/John%20E.%20Hopcroft,%20Rajeev%20Motwani,%20Jeffrey%20D.%20Ullman-Introduction%20to%20Automata%20Theory,%20Languages,%20and%20Computations-Prentice%20Hall%20\(2006\).pdf](http://ce.sharif.edu/courses/94-95/1/ce414-2/resources/root/Text%20Books/Automata/John%20E.%20Hopcroft,%20Rajeev%20Motwani,%20Jeffrey%20D.%20Ullman-Introduction%20to%20Automata%20Theory,%20Languages,%20and%20Computations-Prentice%20Hall%20(2006).pdf)

**MOOCs Courses Links:**

- <https://nptel.ac.in/courses/106/104/106104148/>
- <https://nptel.ac.in/courses/106/104/106104028/>

### @The CO-PO Mapping Matrix

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

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****310243: Systems Programming and Operating System****Teaching Scheme:****TH: 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), Principles of Programming Languages (210255), Microprocessor (210254)

**Companion Course:** Laboratory Practice I (310248)

**Course Objectives:**

- To get acquainted with the basics of System Programming
- To acquire knowledge of data structures used in the design of System Software
- To be familiar with the format of object modules, the functions of linking, relocation, and loading
- To comprehend the structures and functions of Operating Systems and process management.
- To deal with concurrency and deadlock in the Operating System
- To learn and understand memory management of Operating System

**Course Outcomes:**

On completion of the course, learners should be able to

**CO1:** Analyze and synthesize basic System Software and its functionality.

**CO2:** Identify suitable data structures and Design & Implement various System Software

**CO3:** Compare different loading schemes and analyze the performance of linker and loader

**CO4:** Implement and Analyze the performance of process scheduling algorithms

**CO5:** Identify the mechanism to deal with deadlock and concurrency issues

**CO6:** Demonstrate memory organization and memory management policies

**Course Contents****Unit I****Introduction****08 Hours**

Introduction to Systems Programming, Need of systems programming, Software Hierarchy, Types of software: system software and application software, Machine structure.

**Evolution of components of systems programming:** Text Editors, Assembler, Macros, Compiler, Interpreter, Loader, Linker, Debugger, Device Drivers, Operating System.

**Elements of Assembly Language Programming:** Assembly Language statements, Benefits of Assembly Language, A simple Assembly scheme, Pass Structure of Assembler.

**Design of two pass assembler:** Processing of declaration statements, Assembler Directives and imperative statements, Advanced Assembler Directives, Intermediate code forms, Pass I and Pass II of two pass Assembler.

**#Exemplar/Case Studies**

Study of Debugging tools like GDB

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

CO1, CO2, CO3

**Unit II****Macro Processor and Compilers****06 Hours**

Introduction, **Features of a Macro facility:** Macro instruction arguments, Conditional Macro expansion, Macro calls within Macros, Macro instructions, Defining Macro, Design of two pass Macro processor, Concept of single pass Macro processor.

**Introduction to Compilers:** Phases of Compiler with one example, Comparison of compiler and Interpreter.

#Exemplar/Case Studies	GNU M4 Macro Processor	
*Mapping of Course Outcomes for Unit II	CO1, CO2, CO3	
Unit III	Linkers and Loaders	07 Hours
Introduction, <b>Loader schemes</b> : Compile and Go, General Loader Scheme, Absolute Loaders, Subroutine Linkages, Relocating Loaders, Direct linking Loaders, Overlay structure, Design of an Absolute Loader, Design of Direct linking Loader, Self-relocating programs, Static and Dynamic linking.		
#Exemplar/Case Studies	Study the concepts of Class loading in Java.	
*Mapping of Course Outcomes for Unit III	CO1, CO2, CO3	
Unit IV	Operating System	07 Hours
<b>Introduction:</b> Evolution of OS, Operating System Services, Functions of Operating System. <b>Process Management:</b> Process, Process States: 5 and 7 state model, process control block, Threads, Thread lifecycle, Multithreading Model, process control system calls. <b>Process Scheduling:</b> Uni-processor Scheduling, Scheduling: Preemptive, Non-preemptive, Long-term, Medium-term, Short term scheduling. <b>Scheduling Algorithms:</b> FCFS, SJF, RR, and Priority.		
#Exemplar/Case Studies	Process management in Linux /Windows/Android Readers-Writers problem/Producer Consumer problem/Dining Philosopher problem.	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Synchronization and Concurrency Control	07 Hours
<b>Concurrency:</b> principle and issues with concurrency, Mutual Exclusion, Hardware approach, Software approach, Semaphore, Mutex and monitor, Reader writer problem, producer Consumer problem, Dining Philosopher problem. <b>Deadlocks:</b> Principle of deadlock, Deadlock prevention, deadlock avoidance, deadlock detection, deadlock recovery.		
#Exemplar/Case Studies	Concurrency Mechanism: Unix/Linux/Windows.	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Memory Management	07 Hours
<b>Introduction:</b> Memory Management concepts, Memory Management requirements. <b>Memory Partitioning:</b> Fixed Partitioning, Dynamic Partitioning, Buddy Systems Fragmentation, Paging, Segmentation, Address translation. <b>Placement Strategies:</b> First Fit, Best Fit, Next Fit and Worst Fit. <b>Virtual Memory (VM):</b> Concepts, Swapping, VM with Paging, Page Table Structure, Inverted Page Table, Translation Lookaside Buffer, Page Size, VM with Segmentation, VM with Combined paging and segmentation. <b>Page Replacement Policies:</b> First In First Out (FIFO), Last Recently Used (LRU), Optimal, Thrashing.		
#Exemplar/Case Studies	Memory management in Linux /Windows/Android	
*Mapping of Course Outcomes for Unit VI	CO6	

## Learning Resources

**Text Books:**

1. John Donovan, "System Programming", McGraw Hill, ISBN 978-0-07-460482-3.
2. Dhamdhere D., "Systems Programming and Operating Systems", McGraw Hill, ISBN 0 - 07 - 463579 – 4
3. Silberschatz, Galvin, Gagne, "Operating System Principles", 9<sup>th</sup> Edition, Wiley, ISBN 978-1-118-06333-0

**Reference Books:**

1. Leland Beck, "System Software: An Introduction to systems programming", Pearson
2. John R. Levine, Tony Mason, Doug Brown, "Lex & Yacc", 1st Edition, O'REILLY, ISBN 81-7366-062-X.
3. Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, "Compilers Principles, Techniques, and Tools", Addison Wesley, ISBN 981-235-885-4

**e-Books :**

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

**MOOCs Courses Links:**

- <https://www.udacity.com/course/introduction-to-operating-systems--ud923>
- Nptel video lecture link: <https://nptel.ac.in/courses/106/105/106105214/>
- <https://www.edx.org/course/computer-hardware-and-operating-systems>
- [https://onlinecourses.nptel.ac.in/noc19\\_cs50/preview](https://onlinecourses.nptel.ac.in/noc19_cs50/preview)
- <https://www.udemy.com/course/system-programming/>

### @The CO-PO Mapping Matrix

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

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****310244: Computer Networks and Security****Teaching Scheme:****TH: 03****Hours/Week****Credit: 03****Examination Scheme:****Mid-Sem (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:** --**Companion Course:** Computer Networks and Security Laboratory (310247)**Course Objectives:**

- To understand the fundamental concepts of networking standards, protocols and technologies
- To learn different techniques for framing, error control, flow control and routing
- To learn different layer protocols in the protocol stacks
- To understand modern network architectures with respect to design and performance
- To learn the fundamental concepts of Information Security

**Course Outcomes:**

On completion of the course, learners should be able to

- CO1:** Summarize fundamental concepts of Computer Networks, architectures, protocols and technologies
- CO2:** Illustrate the working and functions of data link layer
- 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:** Comprehend the basics of Network Security

**Course Contents**

<b>Unit I</b>	<b>Introduction To Computer Networks</b>	<b>06 Hours</b>
<p><b>Definition, Types of Networks:</b> Local area networks (LAN), Metropolitan area networks (MAN), Wide area networks (WAN), Wireless networks, Networks Software, Protocol, Design issues for the Network layers. <b>Network Models:</b> The OSI Reference Model, TCP/IP Model, Network Topologies, Types of Transmission Medium. <b>Network Architectures:</b> Client-Server, Peer To Peer, Hybrid. <b>Network Devices:</b> Bridge, Switch, Router, Gateway, Access Point. <b>Line Coding Schemes:</b> Manchester and Differential Manchester Encodings, Frequency Hopping (FHSS) and Direct Sequence Spread Spectrum (DSSS).</p>		

<b>#Exemplar/Case Studies</b>	Study of Campus wide networking.
<b>*Mapping of Course Outcomes for Unit I</b>	CO1

<b>Unit II</b>	<b>Data Link Layer</b>	<b>08 Hours</b>
<p>Introduction, functions. <b>Design Issues:</b> Services to Network Layer, Framing. <b>ARQ strategies:</b> Error Detection and correction, Parity Bits, Hamming Codes (11/12-bits) and CRC. <b>Flow Control Protocols:</b> Unrestricted Simplex, Stop and Wait, Sliding Window Protocol. <b>WAN Connectivity:</b> PPP and HDLC. <b>MAC Sub layer:</b> Multiple Access Protocols: Pure and Slotted ALOHA, CSMA, WDMA, CSMA/CD, CSMA/CA, Binary Exponential Back-off algorithm, Introduction to Ethernet IEEE 802.3, IEEE 802.11 a/b/g/n, IEEE 802.15 and IEEE 802.16 Standards.</p>		

<b>#Exemplar/Case Studies</b>	Demonstration of DLL protocols on Simulator
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<b>*Mapping of Course Outcomes for Unit II</b>	CO2	
	<b>Unit III</b>	<b>Network Layer</b>
<b>08 Hours</b>		
<p><b>Introduction:</b> Functions of Network layer. <b>Switching Techniques:</b> Circuit switching, Message Switching, Packet Switching. <b>IP Protocol:</b> Classes of IP (Network addressing), IPv4 , IPv6, Network Address Translation, Sub-netting , CIDR. <b>Network layer Protocols:</b> ARP, RARP, ICMP, IGMP. <b>Network Routing and Algorithms:</b> Static Routing, Dynamic Routing, Distance Vector Routing, Link State Routing, Path Vector. <b>Routing Protocols:</b> RIP, OSPF, BGP, MPLS. <b>Routing in MANET:</b> AODV, DSR, Mobile IP.</p>		
<b>#Exemplar/Case Studies</b>	Demonstration of Routing Protocols on simulator.	
<b>*Mapping of Course Outcomes for Unit III</b>	CO3	
<b>Unit IV</b>	<b>Transport Layer</b>	<b>07 Hours</b>
<p>Process to Process Delivery, Services, Socket Programming. <b>Elements of Transport Layer Protocols:</b> Addressing, Connection establishment, Connection release, Flow control and buffering, Multiplexing, Congestion Control. <b>Transport Layer Protocols:</b> TCP and UDP, SCTP, RTP, Congestion control and Quality of Service (QoS), Differentiated services, TCP and UDP for Wireless networks.</p>		
<b>#Exemplar/Case Studies</b>	Demonstration of Transport layer protocols on Simulator.	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO4	
<b>Unit V</b>	<b>Application Layer</b>	<b>06 Hours</b>
Introduction, Web and HTTP, Web Caching, DNS, Email: SMTP, MIME, POP3, Webmail, FTP, TELNET, DHCP, SNMP.		
<b>#Exemplar/Case Studies</b>	Study of Application Layer protocols using network protocol analyzer. e.g. Wireshark	
<b>*Mapping of Course Outcomes for Unit V</b>	CO5	
<b>Unit VI</b>	<b>Security</b>	<b>07 Hours</b>
<p>Introduction, Security services, Need of Security, Key Principles of Security, Threats and Vulnerabilities, Types of Attacks, ITU-T X.800 Security Architecture for OSI, Security Policy and mechanisms, Operational Model of Network Security, Symmetric and Asymmetric Key Cryptography.</p> <p>Security in Network, Transport and Application: Introduction of IPSec, SSL, HTTPS, S/MIME, Overview of IDS and Firewalls.</p>		
<b>#Exemplar/Case Studies</b>	Study of security protocols in Network, Transport and Application Layer using network protocol analyzer. e.g. Wireshark	
<b>*Mapping of Course Outcomes for Unit VI</b>	CO6	
<b>Learning Resources</b>		
<p><b>Text Books :</b></p> <ol style="list-style-type: none"> <li>Fourauzan B., "Data Communications and Networking", 5<sup>th</sup> Edition, Tata McGraw-Hill, Publications, ISBN:0-07 – 058408 – 7</li> <li>Andrew S. Tanenbaum, Computer Networks, 5th Edition, Pearson India, 2012.</li> </ol>		

**Reference Books :**

1. Kurose, Ross, "Computer Networking a Top Down Approach Featuring the Internet", Pearson, ISBN-10: 0132856204
2. L. Peterson and B. Davie, "Computer Networks: A Systems Approach", 5th Edition, Morgan-Kaufmann, 2012.
3. Douglas E. Comer & M.S Narayanan,"Computer Network & Internet", Pearson Education
4. William Stallings, "Cryptography and Network Security: Principles and Practice", 4th Edition
5. Pachghare V. K., "Cryptography and Information Security", 3<sup>rd</sup> Edition, PHI,

**e-Books :**

- <https://people.cs.clemson.edu/~jmarty/courses/kurose/KuroseCh1-2.pdf>
- [http://eti2506.elimu.net/Introduction/Books/Data\\_Communications\\_and\\_Networking\\_By\\_Behrouz\\_A.Forouzan.pdf](http://eti2506.elimu.net/Introduction/Books/Data_Communications_and_Networking_By_Behrouz_A.Forouzan.pdf)
- <http://intronetworks.cs.luc.edu/current/ComputerNetworks.pdf>
- [https://www.tutorialspoint.com/data\\_communication\\_computer\\_network/data\\_communication\\_on\\_computer\\_network\\_tutorial.pdf](https://www.tutorialspoint.com/data_communication_computer_network/data_communication_on_computer_network_tutorial.pdf)

**Case Study:**

- <https://slideplayer.com/slide/6106945>
- <http://www.worldcolleges.info/sites/default/files/Cisco - Ccie Fundamental - Network Design And Case Studies.PDF>
- [http://vlabs.iitb.ac.in/vlabs-dev/labs\\_local/computer-networks/labs/explist.php](http://vlabs.iitb.ac.in/vlabs-dev/labs_local/computer-networks/labs/explist.php)

**MOOCs Courses link:**

- [nptel.ac.in/courses/106/105/106105183](http://nptel.ac.in/courses/106/105/106105183)
- [nptel.ac.in/courses/106/105/106105080](http://nptel.ac.in/courses/106/105/106105080)
- [nptel.ac.in/courses/106/105/106105081](http://nptel.ac.in/courses/106/105/106105081)
- [nptel.ac.in/courses/106/106/106106091](http://nptel.ac.in/courses/106/106/106106091)
- [nptel.ac.in/courses/106/105/106105031](http://nptel.ac.in/courses/106/105/106105031)
- <https://www.mooc-list.com/tags/computer-networking>
- <https://www.coursera.org/courses?query=computer%20network>

**@The CO-PO Mapping Matrix**

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

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****Elective I****310245(A): Internet of Things and Embedded Systems**[Home](#)**Teaching Scheme:****TH: 03****Hours/Week****Credit: 03****Examination Scheme:****Mid-Sem (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:** Computer Networks and Security (310244)**Companion Course:** Laboratory Practice I (310248)**Course Objectives:**

- To understand fundamentals of Internet of Things (IoT) and Embedded Systems
- To learn advances in Embedded Systems and IoT
- To learn methodologies for IoT application development
- To learn the IoT protocols, cloud platforms and security issues in IoT
- To learn real world application scenarios of IoT along with its societal and economic impact using case studies and real time examples

**Course Outcomes:**

On completion of the course, learners should be able to

- CO1:** Understand the fundamentals and need of Embedded Systems for the Internet of Things  
**CO2:** Apply IoT enabling technologies for developing IoT systems  
**CO3:** Apply design methodology for designing and implementing IoT applications  
**CO4:** Analyze IoT protocols for making IoT devices communication  
**CO5:** Design cloud based IoT systems  
**CO6:** Design and Develop secured IoT applications

**Course Contents**

<b>Unit I</b>	<b>Introduction to Embedded Systems</b>	<b>07 Hours</b>
Definition, Characteristics of Embedded System, Real time systems, Real time tasks. <b>Processor basics:</b> General Processors in Computer Vs Embedded Processors, Microcontrollers, Microcontroller Properties, Components of Microcontrollers, System-On-Chip and its examples, Components of Embedded Systems, Introduction to embedded processor.		
<b>#Exemplar/Case Studies</b>	Installation of Real Time Operating System	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1,CO2	
<b>Unit II</b>	<b>Internet of Things : Concepts</b>	<b>07 Hours</b>

**Introduction to Internet of Things (IoT):** Definition, Characteristics of IoT, Vision, Trends in Adoption of IoT, IoT Devices, IoT Devices Vs Computers, Societal Benefits of IoT, Technical Building Blocks. **Physical Design of IoT:** Things in IoT, Interoperability of IoT Devices, Sensors and Actuators, Need of Analog / Digital Conversion. **Logical Design of IoT:** IoT functional blocks, IoT enabling technologies, IoT levels and deployment templates, Applications in IoT.

<b>#Exemplar/Case Studies</b>	Exemplary device: Raspberry Pi / Arduino: Programming: Arduino IDE/ Python, Interfacing. Other IoT Devices.
<b>*Mapping of Course Outcomes for Unit II</b>	CO1,CO2

<b>Unit III</b>	<b>IoT: Design Methodology</b>	<b>07 Hours</b>		
<b>IoT Design Methodology:</b> Steps, Basics of IoT Networking, Networking Components, Internet Structure, Connectivity Technologies, IoT Communication Models and IoT Communication APIs, Sensor Networks, Four pillars of IoT: M2M, SCADA, WSN, RFID.				
<b>#Exemplar/Case Studies</b>	Home Automation using IoT communication models and IoT Communication APIs.			
<b>*Mapping of Course Outcomes for Unit III</b>	CO3,CO4			
<b>Unit IV</b>	<b>IoT Protocols</b>	<b>07 Hours</b>		
Protocol Standardization for IoT, M2M and WSN Protocols, RFID Protocol, Modbus Protocol, Zigbee Architecture. <b>IP based Protocols:</b> MQTT (Secure), 6LoWPAN, LoRa.				
<b>#Exemplar/Case Studies</b>	LoRa based Smart Irrigation System.			
<b>*Mapping of Course Outcomes for Unit IV</b>	CO4,CO5			
<b>Unit V</b>	<b>Cloud Platforms for IoT</b>	<b>07 Hours</b>		
Software Defined Networking, Introduction to Cloud Storage Models, Communication API. <b>WAMP:</b> AutoBahn for IoT, Xively Cloud for IoT. <b>Python Web Application Framework:</b> Django Architecture and application development with Django, Amazon Web Services for IoT, SkyNet IoT Messaging Platform, RESTful Web Service, GRPC,SOAP.				
<b>#Exemplar/Case Studies</b>	Smart parking, Forest Fire Detection			
<b>*Mapping of Course Outcomes for Unit V</b>	CO4, CO5			
<b>Unit VI</b>	<b>Security in IoT</b>	<b>07 Hours</b>		
Introduction, Vulnerabilities of IoT, Security Requirements, Challenges for Secure IoT, Threat Modeling. <b>Key elements of IoT Security:</b> Identity establishment, Access control, Data and message security, Non-repudiation and availability, Security model for IoT, Challenges in designing IOT applications, lightweight cryptography.				
<b>#Exemplar/Case Studies</b>	Home Intrusion Detection			
<b>*Mapping of Course Outcomes for Unit VI</b>	CO2, CO6			
<b>Learning Resources</b>				
<b>Text Books:</b>				
<ol style="list-style-type: none"> <li>1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515</li> <li>2. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", 2nd Edition,Wiley Publication, ISBN: 978-1-119-99435-0</li> </ol>				
<b>Reference Books:</b>				
<ol style="list-style-type: none"> <li>1. Dawoud Shenouda Dawoud, Peter Dawoud, "Microcontroller and Smart Home Networks", ISBN: 9788770221566, e-ISBN: 9788770221559</li> <li>2. Charles Crowell, "IoT-Internet of Things for Beginners: An Easy-to-Understand Introduction to IoT", ISBN-13 : 979-8613100194</li> <li>3. David Hanes, Gonzalo Salgueiro, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press, ISBN-13: 978-1-58714-456-1 ISBN-10: 1-58714-456-5</li> </ol>				

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| 4. David Etter, "IoT Security: Practical guide book", amazon kindle Page numbers, source ISBN : 1540335011.                      |
| 5. Brian Russell, Drew Van Duren, "Practical Internet of Things Security", Second Edition, Packt Publishing, ISBN: 9781788625821 |

**e-Books :**

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

**MOOCs Courses link**

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

**@The CO-PO Mapping Matrix**

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

**Savitribai Phule Pune University**  
**Third Year of Computer Engineering (2019 Course)**  
**Elective I**  
**310245(B): Human Computer Interface**

<b>Teaching Scheme:</b> TH: <b>03</b> <b>Hours/Week</b>	<b>Credit: 03</b>	<b>Examination Scheme:</b> Mid-Sem (TH) : <b>30 Marks</b> End-Sem (TH): <b>70 Marks</b>
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**Prerequisites Courses:** Computer Graphics (210244), Software Engineering (210253)

**Companion Course:** Laboratory Practice I (310248)

**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:** 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 analyze and evaluate the effectiveness of a user-interface design  
**CO4:** To implement the interactive designs for feasible data search and retrieval  
**CO5:** To analyze the scope of HCI in various paradigms like ubiquitous computing, virtual reality ,multi-media, World wide web related environments  
**CO6:** To analyze and identify user models, user support, and stakeholder requirements of HCI systems

**Course Contents**

<b>Unit I</b>	<b>Introduction and Foundation of HCI</b>	<b>07 Hours</b>
<b>Foundation:</b> Human Memory. <b>Thinking:</b> 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. <b>Importance of User Interface:</b> Defining user Interface, Brief History of Human-Computer Interface, Good and Poor Design- Importance of good design.		
<b>#Exemplar/Case Studies</b>	Paper prototype – Design elements of GUI	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1,CO6	
<b>Unit II</b>	<b>Human Perspective in Interaction Design Process</b>	<b>07 Hours</b>
<b>Know your user/client:</b> 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. <b>Design Guidelines:</b> Navigating the interface, Organizing the display, Getting user's attention, Facilitating data entry. <b>Principles:</b> 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.

<b>#Exemplar/Case Studies</b>	Registration form design.
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<b>*Mapping of Course Outcomes for Unit II</b>	CO1,CO2
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<b>Unit III</b>	<b>Interaction Styles and HCI in Software Process</b>	<b>07 Hours</b>
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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.

<b>#Exemplar/Case Studies</b>	Comparison - GUI and Web design with a real time example.
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<b>*Mapping of Course Outcomes for Unit III</b>	CO1,CO3,CO5
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<b>Unit IV</b>	<b>Usability Evaluation and Universal Design</b>	<b>07 Hours</b>
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**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.

<b>#Exemplar/Case Studies</b>	GOMS model - Adding items to a cart of e-shopping website.
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<b>*Mapping of Course Outcomes for Unit IV</b>	CO1,CO3
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<b>Unit V</b>	<b>HCI Paradigms</b>	<b>07 Hours</b>
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**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 fudgeability, 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.

<b>#Exemplar/Case Studies</b>	Interface Design- Pattern gesture recognition
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<b>*Mapping of Course Outcomes for Unit V</b>	CO1,CO3,CO4
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<b>Unit VI</b>	<b>HCI for Mobile and Handheld devices</b>	<b>07 Hours</b>
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**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", 6<sup>th</sup> 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<sup>th</sup> 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](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.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/ PO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	3	1	1	1	1	-	-	-	1	1	1
CO2	2	2	-	-	-	-	-	2	1	-	-	-
CO3	-	-	2	-	-	-	-	1	-	-	1	-
CO4	-	-	-	2	3	1	-	-	1	-	-	-
CO5	-	2	2	-	2	2	2	-	-	2	2	3
CO6	-	-	2	1	2	3	-	1	-	-	-	2

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****Elective I****310245(C): Distributed Systems** Home

**Teaching Scheme:**  
**TH: 03**  
**Hours/Week**

**Credit: 03****Examination Scheme:****Mid-Sem (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:** Computer Networks and Security(310244)**Companion Course:** Laboratory Practice I (310248)**Course Objectives:**

- To learn the fundamentals of Distributed Systems
- To learn types of communication and synchronization in Distributed Systems
- To acquaint with the Distributed File Systems
- To understand consistency and replication in Distributed Systems
- To understand the fault tolerance based Distributed Systems

**Course Outcomes:**

On completion of the course, learners should be able to

**CO1:** Analyze Distributed Systems types and architectural styles**CO2:** Implement communication mechanism in Distributed Systems**CO3:** Implement the synchronization algorithms in Distributed System applications**CO4:** Develop the components of Distributed File System**CO5:** Apply replication techniques and consistency model in Distributed Systems**CO6:** Build fault tolerant Distributed Systems**Course Contents**

<b>Unit I</b>	<b>Introduction</b>	<b>07 Hours</b>
Defining Distributed Systems, Characteristics, Middleware and Distributed Systems. <b>Design goals:</b> Supporting resource sharing, Making distribution transparent, Open, Scalable, Pitfalls. <b>Types of Distributed Systems:</b> High Performance Distributed Computing, Distributed Information Systems, Pervasive Systems. <b>Architectural styles:</b> Layered architectures, Object based architectures, Publish Subscribe architectures. <b>Middleware organization:</b> Wrappers, Interceptors, Modifiable middleware. <b>System architecture:</b> Centralized, Decentralized, Hybrid, Example architectures – Network File System, Web.		
<b>#Exemplar/Case Studies</b>	Case Study of Middleware System that includes Design, Architecture and Application.	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1	
<b>Unit II</b>	<b>Communication</b>	<b>07 Hours</b>
<b>Introduction:</b> Layered Protocols, Types of Communication, Remote Procedural Call- Basic RPC Operation, Parameter Passing, RPC-based application support, Variations on RPC, Example: DCE RPC, Remote Method Invocation. <b>Message Oriented Communication:</b> Simple Transient Messaging with Sockets, Advanced Transient Messaging, Message Oriented Persistent Communication, Examples. <b>Multicast Communication:</b> Application Level Tree-Based Multicasting, Flooding-Based Multicasting, Gossip-Based Data Dissemination.		
<b>#Exemplar/Case Studies</b>	Apache Kafka Distributed Event Streaming Platform, gRPC Open Source RPC Framework	

<b>*Mapping of Course Outcomes for Unit II</b>	CO2	
	<b>Unit III</b>	<b>Synchronization</b>
<b>07 Hours</b>		
<p><b>Clock Synchronization:</b> Physical Clocks, Clock Synchronization Algorithms. <b>Logical Clocks –</b> Lamport's Logical clocks, Vector Clocks. <b>Mutual Exclusion:</b> Overview, Centralized Algorithm, Distributed Algorithm, Token-Ring Algorithm, Decentralized Algorithm. <b>Election Algorithms:</b> Bully Algorithm, Ring Algorithm. <b>Location Systems:</b> GPS, Logical Positioning of nodes, Distributed Event Matching. <b>Gossip-Based Contribution:</b> Aggregation, A Peer-Sampling Service, Gossip-Based Overlay Construction.</p>		
<b>#Exemplar/Case Studies</b>	Design Time Synchronization Mechanism in Distributed Gaming	
<b>*Mapping of Course Outcomes for Unit III</b>	CO3	
<b>Unit IV</b>	<b>Naming and Distributed File Systems</b>	<b>07 Hours</b>
Names, Identifiers, Addresses, Flat Naming, Structured Naming, Attributed Based Naming, Introduction to Distributed File Systems, File Service Architecture. <b>Case study:</b> Suns Network file System, Andrew File System.		
<b>#Exemplar/Case Studies</b>	Study of Google File System	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO4	
<b>Unit V</b>	<b>Consistency and Replication</b>	<b>07 Hours</b>
<b>Introduction:</b> Reasons for Replication, Replication as Scaling Technique. <b>Data-Centric Consistency Models:</b> Continuous Consistency, Consistent Ordering of Operations. <b>Client-Centric Consistency Models:</b> Eventual Consistency, Monotonic Reads, Monotonic Writes, Read Your Writes, Writes Follow Reads. <b>Replica Management:</b> Finding the best server location, Content Replication and Placement, Content Distribution, Managing Replicated Objects. <b>Consistency Protocols:</b> Continuous Consistency, Sequential Consistency, Cache Coherence Protocols, Example: Caching, and Replication in the web.		
<b>#Exemplar/Case Studies</b>	Study of HDFS Architecture for Data Replication	
<b>*Mapping of Course Outcomes for Unit V</b>	CO5	
<b>Unit VI</b>	<b>Fault Tolerance</b>	<b>07 Hours</b>
<b>Introduction to Fault Tolerance:</b> Basic Concepts, Failure Models, Failure Masking by Redundancy. <b>Process Resilience:</b> Resilience by Process Groups, Failure Masking and Replication, Example: Paxos, Consensus in faulty systems with crash failures, some limitations on realizing Fault Tolerant tolerance, Failure Detection. <b>Reliable Client Server Communication:</b> Point to Point Communication, RPC Semantics in the Presence of Failures. <b>Reliable Group Communication:</b> Atomic multicast, Distributed commit. <b>Recovery:</b> Introduction, Checkpointing, Message Logging, Recovery Oriented Computing.		
<b>#Exemplar/Case Studies</b>	Study of any Open Source Tool for Building Fault-Tolerant System such as Circuit Breaker/Nginx/HaProxy/Akka	
<b>*Mapping of Course Outcomes for Unit VI</b>	CO6	

## Learning Resources

**Text Books:**

1. Maarten van Steen, Andrew S. Tanenbaum, "Distributed System", Third edition, version 3
2. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems Concepts and Design", Fifth edition

**Reference Books:**

1. P.K.Sinha, "Distributed Operating System", Wiley, IEEE Press
2. Singhal and Shivaratri, "Advanced Concept in Operating Systems", McGraw Hill
3. Vijay K.Garg, "Elements of Distributed Computing", Wiley

**e-Books :**

- Martin Kleppmann, "Designing Data-Intensive Applications", Oreilly

**MOOC Courses links:**

- Prof. Rajiv Misra, Distributed System, <https://nptel.ac.in/courses/106/106/106106168/#>
- Prof. Rajiv Misra, Cloud computing and Distributed System
- Prof. Rajiv Misra, Distributed System, <https://nptel.ac.in/courses/106/104/106104182/>

## @TheCO-POMappingMatrix

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

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****Elective I****310245(D): Software Project Management** Home**Teaching Scheme:****TH: 03****Hours/Week****Credit: 03****Examination Scheme:****Mid-Semester (TH) : 30 Marks****End-Sem (paper): 70 Marks****Prerequisites Courses:** Software Engineering (210253)**Companion Course:** Laboratory Practice I (310248)**Course Objectives:**

- To understand the fundamentals of Software Project Management
- To investigate software project planning and management tools
- To learn software project scheduling and tracking
- To discuss about the agile project management
- To know people management in software project

**Course Outcomes:**

On completion of the course, learners should be able to

**CO1:** Comprehend Project Management Concepts**CO2:** Use various tools of Software Project Management**CO3:** Schedule various activities in software projects**CO4:** Track a project and manage changes**CO5:** Apply Agile Project Management**CO6:** Analyse staffing process for team building and decision making in Software Projects and Management**Course Contents**

<b>Unit I</b>	<b>Introduction to Software Project Management</b>	<b>07 Hours</b>
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Project Definition, Project versus Flow type work, Project Lifecycle, Processes and Knowledge Areas in Project Management (PM), Build or Buy decision, Work Breakdown Structure (WBS) and its types, Introduction to PMBOK, Program and Portfolio Management.

<b>#Exemplar/Case Studies</b>	Analysis of a project using PMBOK concepts
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<b>*Mapping of Course Outcomes for Unit I</b>	CO1
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<b>Unit II</b>	<b>Project Planning and Project Management Tools</b>	<b>07 Hours</b>
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**Project Planning:** Steps for Project Planning, PERT and Gantt Charts, Gantt Project, Microsoft Project and Primavera Project Management Software, Objectives of Activity planning, Project Schedules, Activities, Sequencing and Scheduling, Network Planning Models, Formulating Network Model.

<b>#Exemplar/Case Studies</b>	Create software project plan using any tool.
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<b>*Mapping of Course Outcomes for Unit II</b>	CO2
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<b>Unit III</b>	<b>Activity based Scheduling</b>	<b>07 Hours</b>
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Introduction, Objectives of Activity Planning, Project Schedules. **Activities:** Sequencing and Scheduling, Network Planning Models, Formulating Network Model, Activity relationships (FS,SF,SS,FF), Forward Pass and Backward Pass techniques, Critical Path concept and remedies.

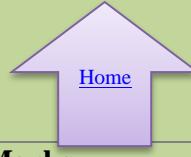
#Exemplar/Case Studies	Apply the critical path technique to the project			
*Mapping of Course Outcomes for Unit III	CO3			
<b>Unit IV</b>	<b>Project Tracking and Control</b>	<b>07 Hours</b>		
Introduction, Collection of Project data, Visualizing progress, Cost monitoring, Earned Value Analysis, Project tracking, Change Control, Software Configuration Management, Managing contracts, Contract Management.				
#Exemplar/Case Studies	Analyze the effect of a major requirement change on the schedule			
*Mapping of Course Outcomes for Unit IV	CO4			
<b>Unit V</b>	<b>Agile Project Management</b>	<b>07 Hours</b>		
Predictive versus Empirical Management, Comparison between Non-Agile and Agile Project, Three stages of Agile Project, Estimation, Scope Management, Roles and Responsibilities, Scheduling and Tracking.				
#Exemplar/Case Studies	Analyse the same project using Agile. Create the three stages of the project.			
*Mapping of Course Outcomes for Unit V	CO5			
<b>Unit VI</b>	<b>Staffing in Software Projects</b>	<b>07 Hours</b>		
Managing People, Organizational behaviour, Best methods of Staff Selection, Motivation, The Oldham, Hackman job characteristic Model, Stress, Health and Safety, Ethical and Professional concerns, Working in Teams, Decision Making, Organizational structures, Dispersed and Virtual Teams, Communications Genres, Communication Plans.				
#Exemplar/Case Studies	Analyse a case study for a distributed team and comment			
*Mapping of Course Outcomes for Unit VI	CO6			
<b>Learning Resources</b>				
<b>Text Books:</b>				
<ol style="list-style-type: none"> <li>1. Bob Hughes, Mike Cotterell and Rajib Mall, "Software Project Management", Sixth Edition, Tata McGraw Hill, New Delhi, 2017.</li> <li>2. Robert K. Wysocki, "Effective Software Project Management", Wiley Publication, 2011.</li> </ol>				
<b>Reference Books :</b>				
<ol style="list-style-type: none"> <li>1. Ken Schwaber, "Agile Project Management", Microsoft Press, 2004</li> <li>2. Walker Royce, "Software Project Management", Addison-Wesley, 1998.</li> <li>3. Jalote Pankaj, "Software Project Management in Practice", Addison-Wesley Professional, 2002</li> <li>4. PMBOK Guide</li> </ol>				
<b>e-Books :</b>				
<ul style="list-style-type: none"> <li>• <a href="https://www.kornev-online.net/ITIL/Mcgraw.Hill.Software_Project_Management_2nd_Edition.pdf">https://www.kornev-online.net/ITIL/Mcgraw.Hill.Software_Project_Management_2nd_Edition.pdf</a></li> <li>• <a href="http://library.lol/main/B96E3B122326F8D2C6FBD35A5E978422">http://library.lol/main/B96E3B122326F8D2C6FBD35A5E978422</a></li> </ul>				
<b>MOOCs Courses Links:</b>				
<ul style="list-style-type: none"> <li>• <a href="https://onlinecourses.nptel.ac.in/noc19_cs70/preview">https://onlinecourses.nptel.ac.in/noc19_cs70/preview</a></li> <li>• <a href="https://onlinecourses.nptel.ac.in/noc19_cs70/preview">Software Project Management By Prof. Rajib Mall &amp; Prof. Durga Prasad Mohapatra   IIT Kharagpur</a></li> </ul>				

- [Agilealliance.org](https://www.agilealliance.org)
- [Scrum.org](https://www.scrum.org)
- [Scrumalliance.org](https://www.scrumalliance.org)

### @The CO-PO Mapping Matrix

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

**Savitribai Phule Pune University**  
**Third Year of Computer Engineering (2019 Course)**  
**310246:Database Management Systems Laboratory**


  
Home

<b>Teaching Scheme</b> <b>Practical: 04 Hours/Week</b>	<b>Credit Scheme: 02</b>	<b>Examination Scheme and Marks</b> <b>Term work: 25 Marks</b> <b>Practical: 25 Marks</b>
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**Companion Course:** Database Management Systems (310241)

**Course Objectives:**

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

**Course Outcomes:**

On completion of the course, learners will be able to

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

**Guidelines for Instructor's Manual**

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

**Guidelines for Student's Laboratory Journal**

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

**Guidelines for Laboratory /Term Work Assessment**

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

**Guidelines for Practical Examination**

Problem statements must be decided jointly by the internal examiner and external examiner. During practical assessment, maximum weightage should be given to satisfactory implementation of the problem statement. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals, effective and efficient implementation. This will encourage, transparent evaluation and fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.

## **Guidelines for Laboratory Conduction**

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

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

Programming tools recommended: - MYSQL/Oracle, MongoDB, ERD plus, ER Win

### **Virtual Laboratory:**

- <http://vlabs.iitb.ac.in/vlabs-dev/labs/dblab/labs/index.php>

### **Suggested List of Laboratory Experiments/Assignments**

**Assignments from all Groups (A, B, C) are compulsory**

Sr. No.	Group A: SQL and PL/SQL
<b>1. ER Modeling and Normalization:</b> Decide a case study related to real time application in group of 2-3 students and formulate a problem statement for application to be developed. Propose a Conceptual Design using ER features using tools like ERD plus, ER Win etc. (Identifying entities, relationships between entities, attributes, keys, cardinalities, generalization, specialization etc.) Convert the ER diagram into relational tables and normalize Relational data model.  Note: Student groups are required to continue same problem statement throughout all the assignments in order to design and develop an application as a part Mini Project. Further assignments will be useful for students to develop a backend for system. To design front end interface students should use the different concepts learnt in the other subjects also.	
<b>2. SQL Queries:</b> <ol style="list-style-type: none"> <li>a. Design and Develop SQL DDL statements which demonstrate the use of SQL objects such as Table, View, Index, Sequence, Synonym, different constraints etc.</li> <li>b. Write at least 10 SQL queries on the suitable database application using SQL DML statements.</li> </ol> Note: Instructor will design the queries which demonstrate the use of concepts like Insert, Select, Update, Delete with operators, functions, and set operator etc.	
<b>3. SQL Queries - all types of Join, Sub-Query and View:</b> 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	

<p>4.</p>	<p><b>Unnamed PL/SQL code block: Use of Control structure and Exception handling is mandatory.</b></p> <p>Suggested Problem statement:</p> <p>Consider Tables:</p> <ol style="list-style-type: none"> <li>1. Borrower(Roll_no, Name, DateofIssue, NameofBook, Status)</li> <li>2. Fine(Roll_no, Date, Amt)</li> </ol> <ul style="list-style-type: none"> <li>• Accept Roll_no and NameofBook from user.</li> <li>• Check the number of days (from date of issue).</li> <li>• If days are between 15 to 30 then fine amount will be Rs 5 per day.</li> <li>• If no. of days &gt; 30, per day fine will be Rs 50 per day and for days less than 30, Rs. 5 per day.</li> <li>• After submitting the book, status will change from I to R.</li> <li>• If condition of fine is true, then details will be stored into fine table.</li> <li>• Also handles the exception by named exception handler or user define exception handler.</li> </ul> <p style="text-align: center;"><b>OR</b></p> <p>Write a PL/SQL code block to calculate the area of a circle for a value of radius varying from 5 to 9. Store the radius and the corresponding values of calculated area in an empty table named areas, consisting of two columns, radius and area.</p> <p>Note: Instructor will frame the problem statement for writing PL/SQL block in line with above statement.</p>
<p>5.</p>	<p><b>Named PL/SQL Block: PL/SQL Stored Procedure and Stored Function.</b></p> <p>Write a Stored Procedure namely proc_Grade for the categorization of student. If marks scored by students in examination is <math>\leq 1500</math> and <math>\text{marks} \geq 990</math> then student will be placed in distinction category if marks scored are between 989 and 900 category is first class, if marks 899 and 825 category is Higher Second Class.</p> <p>Write a PL/SQL block to use procedure created with above requirement.</p> <p>Stud_Marks(name, total_marks)      Result(Roll,Name, Class)</p> <p>Note: Instructor will frame the problem statement for writing stored procedure and Function in line with above statement.</p>
<p>6.</p>	<p><b>Cursors: (All types: Implicit, Explicit, Cursor FOR Loop, Parameterized Cursor)</b></p> <p>Write a PL/SQL block of code using parameterized Cursor that will merge the data available in the newly created table N_RollCall with the data available in the table O_RollCall. If the data in the first table already exist in the second table then that data should be skipped.</p> <p>Note: Instructor will frame the problem statement for writing PL/SQL block using all types of Cursors in line with above statement.</p>

7.	<p><b>Database Trigger (All Types: Row level and Statement level triggers, Before and After Triggers).</b></p> <p>Write a database trigger on Library table. The System should keep track of the records that are being updated or deleted. The old value of updated or deleted records should be added in Library_Audit table.</p> <p>Note: Instructor will Frame the problem statement for writing PL/SQL block for all types of Triggers in line with above statement.</p>
8.	<p><b>Database Connectivity:</b></p> <p>Write a program to implement MySQL/Oracle database connectivity with any front end language to implement Database navigation operations (add, delete, edit etc.)</p>
<b>Group B: NoSQL Databases</b>	
1.	<p><b>MongoDB Queries:</b></p> <p>Design and Develop MongoDB Queries using CRUD operations. (Use CRUD operations, SAVE method, logical operators etc.).</p>
2.	<p><b>MongoDB - Aggregation and Indexing:</b></p> <p>Design and Develop MongoDB Queries using aggregation and indexing with suitable example using MongoDB.</p>
3.	<p><b>MongoDB - Map reduces operations:</b></p> <p>Implement Map reduces operation with suitable example using MongoDB.</p>
4.	<p><b>Database Connectivity:</b></p> <p>Write a program to implement MongoDB database connectivity with any front end language to implement Database navigation operations (add, delete, edit etc.)</p>
<b>Group C: Mini Project</b>	
1.	<p>Using the <b>database concepts covered in Group A and Group B</b>, develop an application with following details:</p> <ol style="list-style-type: none"> <li>Follow the same problem statement decided in Assignment -1 of Group A.</li> <li>Follow the Software Development Life cycle and other concepts learnt in <b>Software Engineering Course</b> throughout the implementation.</li> <li>Develop application considering: <ul style="list-style-type: none"> <li>Front End : Java/Perl/PHP/Python/Ruby/.net/any other language</li> <li>Backend : MongoDB/MySQL/Oracle</li> </ul> </li> <li>Test and validate application using Manual/Automation testing.</li> <li>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: <ul style="list-style-type: none"> <li>Title of the Project, Abstract, Introduction</li> <li>Software Requirement Specification</li> <li>Conceptual Design using ER features, Relational Model in appropriate Normalize form</li> <li>Graphical User Interface, Source Code</li> <li>Testing document</li> <li>Conclusion.</li> </ul> </li> </ol> <p><b>Note:</b></p> <ul style="list-style-type: none"> <li>Instructor should maintain progress report of mini project throughout the semester from project group</li> <li>Practical examination will be on assignments given above in Group A and Group B only</li> <li>Mini Project in this course should facilitate the Project Based Learning among students</li> </ul>

**@The CO-PO Mapping Matrix**

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

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****310247:Computer Networks and Security Laboratory** Home**Teaching Scheme****Practical: 02 Hours/Week****Credit Scheme: 01****Examination Scheme and Marks****Term work: 25 Marks****Oral: 25 Marks****Companion Course:** Computer Network and Security (310244)**Course Objectives:**

- To learn computer network hardware and software components
- To learn computer network topologies and types of network
- To develop an understanding of various protocols, modern technologies and applications
- To learn modern tools for network traffic analysis
- To learn network programming

**Course Outcomes:**

On completion of the course, learners 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

**CO6:** Use network security services and mechanisms

**Guidelines for Instructor's Manual**

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Oral examination should be jointly conducted by the internal examiner and external examiner. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals, effective and efficient implementations in term work. 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.

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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/C++/JAVA

Programming tool like G++/GCC, Wireshark/Ethereal and Packet Tracer

### **Virtual Laboratory:**

- <http://vlabs.iitb.ac.in/vlab/>

### **Suggested List of Laboratory Experiments/Assignments**

**Assignments from all Groups (A, B, C) are compulsory**

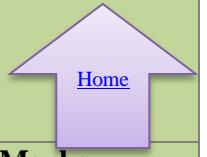
<b>Sr. No.</b>	<b>Group A (Unit I and II): Attempt any two assignments from Sr. No. 1 to 3. Assignments 4 and 5 are compulsory.</b>
1.	Setup a wired LAN using Layer 2 Switch. It includes preparation of cable, testing of cable using line tester, configuration machine using IP addresses, testing using PING utility and demonstrating the PING packets captured traces using Wireshark Packet Analyzer Tool.
2.	Demonstrate the different types of topologies and types of transmission media by using a packet tracer 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.	Write a program for error detection and correction for 7/8 bits ASCII codes using Hamming Codes or CRC.
5.	Write a program to simulate Go back N and Selective Repeat Modes of Sliding Window Protocol in Peer-to-Peer mode.
	<b>Group B (Unit III and IV)</b>
6.	Write a program to demonstrate Sub-netting and find subnet masks.
7.	Write a program to implement link state /Distance vector routing protocol to find suitable path for transmission.
8.	Use packet Tracer tool for configuration of 3 router network using one of the following protocol RIP/OSPF/BGP.
9.	Write a program using TCP socket for wired network for following <ol style="list-style-type: none"> <li>Say Hello to Each other</li> <li>File transfer</li> <li>Calculator</li> </ol>
10.	Write a program using UDP Sockets to enable file transfer (Script, Text, Audio and Video one file each) between two machines.
	<b>Group C (Unit V and VI): Assignment Sr. No. 11 is Compulsory and attempt any four from Assignments Sr. No 12 to 17.</b>
11.	Write a program for DNS lookup. Given an IP address as input, it should return URL and vice-versa.
12.	Installing and configure DHCP server and write a program to install the software on remote machine.

- |     |  |  |  |  |  |  |  |  |  |  |  |  |
|-----|--|--|--|--|--|--|--|--|--|--|--|--|
| 13. | Capture packets using Wireshark, write the exact packet capture filter expressions to accomplish the following and save the output in file: <ol style="list-style-type: none"> <li>1. Capture all TCP traffic to/from Facebook, during the time when you log in to your Facebook account</li> <li>2. Capture all HTTP traffic to/from Facebook, when you log in to your Facebook account</li> <li>3. 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.</li> <li>4. Count how many TCP packets you received from / sent to Face book, and how many of each were also HTTP packets.</li> </ol> |  |  |  |  |  |  |  |  |  |  |  |
| 14. | Study and Analyze the performance of HTTP, HTTPS and FTP protocol using Packet tracer tool.  |  |  |  |  |  |  |  |  |  |  |  |
| 15. | To study the SSL protocol by capturing the packets using Wireshark tool while visiting any SSL secured website (banking, e-commerce etc.).   |  |  |  |  |  |  |  |  |  |  |  |
| 16. | Illustrate the steps for implementation of S/MIME email security through Microsoft® Office Outlook.  |  |  |  |  |  |  |  |  |  |  |  |
| 17. | To study the IPsec (ESP and AH) protocol by capturing the packets using Wireshark tool.  |  |  |  |  |  |  |  |  |  |  |  |

**@The CO-PO Mapping Matrix**

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

**Savitribai Phule Pune University**  
**Third Year of Computer Engineering (2019 Course)**  
**310248: Laboratory Practice I**

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<b>Teaching Scheme</b> <b>Practical: 04 Hours/Week</b>	<b>Credit Scheme:</b> <b>02</b>	<b>Examination Scheme and Marks</b> <b>Term work: 25 Marks</b> <b>Practical: 25 Marks</b>
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**Companion Course:** Systems Programming and Operating System (310243), Elective I (310245)

**Course Objectives:**

- To learn system programming tools
- To learn modern operating system
- To learn various techniques, tools, applications in IoT and Embedded Systems /Human Computer Interface/Distributed Systems/ Software Project Management

**Course Outcomes:**

On completion of the course, learners will be able to

• **Systems Programming and Operating System**

CO1: Implement language translators

CO2: Use tools like LEX and YACC

CO3: Implement internals and functionalities of Operating System

• **Internet of Things and Embedded Systems**

CO4: Design IoT and Embedded Systems based application

CO5: Develop smart applications using IoT

CO6: Develop IoT applications based on cloud environment

**OR**

• **Human Computer Interface**

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, socio-organizational issues, and stakeholder requirements of HCI systems

**OR**

• **Distributed Systems**

CO4: Demonstrate knowledge of the core concepts and techniques in Distributed Systems

CO5: Apply the principles of state-of-the-Art Distributed Systems in real time applications

CO6: Design, build and test application programs on Distributed Systems

**OR**

• **Software Project Management**

CO4: Apply Software Project Management tools

CO5: Implement software project planning and scheduling

CO6: Analyse staffing in software project

**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, punctuality and

## **Guidelines for Practical Examination**

Problem statements must be decided jointly by the internal examiner and external examiner. During practical assessment, maximum weightage should be given to satisfactory implementation of the problem statement. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals, effective and efficient implementation. This will encourage, transparent evaluation and fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.

## **Guidelines for Laboratory Conduction**

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. Use of open source software is encouraged. Based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus. For the elective subjects students should form group of 3-4 students. The faculty coordinator will take care that all the assignment should be assigned to class and minimum two assignments are compulsory for each group.

Programming tools recommended: -

Human computer Interface-GUI in python

Internet of Things and Embedded System- Raspberry Pi/Arduino Programming; Arduino IDE/Python Interfacing. Other IoT devices

Software project management-MS project/Gantt Project/Primavera

### **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>

## **Suggested List of Laboratory Experiments/Assignments Assignments from all Groups (A, B, C) are compulsory**

### **Part I: Systems Programming and Operating System**

Sr. No.	Group A (Any Two Assignments from Sr. No. 1 to 3)
1.	Design suitable Data structures and implement Pass-I and Pass-II of a two-pass assembler for pseudo-machine. Implementation should consist of a few instructions from each category and few assembler directives. The output of Pass-I (intermediate code file and symbol table) should be input for Pass-II.

2.	Design suitable data structures and implement Pass-I and Pass-II of a two-pass macro-processor. The output of Pass-I (MNT, MDT and intermediate code file without any macro definitions) should be input for Pass-II.
3.	Write a program to recognize infix expression using LEX and YAAC.
<b>Group B (Any Two Assignments from Sr. No. 4 to 7)</b>	
4.	Write a program to solve Classical Problems of Synchronization using Mutex and Semaphore.
5.	<u>Write a program to simulate</u> CPU Scheduling Algorithms: FCFS, SJF (Preemptive), Priority (Non-Preemptive) and Round Robin (Preemptive).
6.	<u>Write a program to simulate</u> Memory placement strategies – best fit, first fit, next fit and worst fit.
7.	<u>Write a program to simulate</u> Page replacement algorithm.

## Part II : Elective I

### Suggested List of Laboratory Experiments/Assignments

**(Any Two assignments from each elective subject are compulsory and Instructor will take care that all the assignments should be covered among different batch students)**

#### Internet of Things and Embedded Systems

1. Understanding the connectivity of Raspberry-Pi / Adriano with IR sensor. Write an application to detect obstacle and notify user using LEDs.
2. Understanding the connectivity of Raspberry-Pi /Beagle board circuit with temperature sensor. Write an application to read the environment temperature. If temperature crosses a threshold value, generate alerts using LEDs.
3. Understanding and connectivity of Raspberry-Pi /Beagle board with camera. Write an application to capture and store the image.
4. Create a small dashboard application to be deployed on cloud. Different publisher devices can publish their information and interested application can subscribe.

#### Human Computer Interface

1. Design a paper prototype for selected Graphical User Interface.
2. Implement GOMS (Goals, Operators, Methods and Selection rules) modeling technique to model user's behavior in given scenario.
3. Design a User Interface in Python.
4. To redesign existing Graphical User Interface with screen complexity.

#### Distributed System

1. Implementation of Inter-process communication using socket programming: implementing multithreaded echo server.
2. Implementation of RPC Mechanism.
3. Simulation of election algorithms (Ring and Bully).
4. Implementation of Clock Synchronization: a) NTP b) Lamports clock.

#### Software Project Management

1. **Create Project Plan**
  - Specify project name and start (or finish) date.
  - Identify and define project tasks.
  - Define duration for each project task.
  - Define milestones in the plan
  - Define dependency between tasks
  - Define project calendar.
  - Define project resources and specify resource type
  - Assign resources against each task and baseline the project plan

2.	<p><b>Execute and Monitor Project Plan</b></p> <ul style="list-style-type: none"> <li>▪ Update % Complete with current task status.</li> <li>▪ Review the status of each task.</li> <li>▪ Compare Planned vs Actual Status</li> <li>▪ Review the status of Critical Path</li> <li>▪ Review resources assignation status</li> </ul>
3.	<p><b>Generate Dashboard and Reports</b></p> <ul style="list-style-type: none"> <li>▪ <b>Dashboard</b> <ul style="list-style-type: none"> <li>o Project Overview</li> <li>o Cost Overview</li> <li>o Upcoming Tasks</li> </ul> </li> <li>• <b>Resource Reports</b> <ul style="list-style-type: none"> <li>o Over-allocated Resources</li> <li>o Resource Overview</li> <li>▪ <b>Cost Reports</b> <ul style="list-style-type: none"> <li>o Earned Value Report</li> <li>o Resource Cost Overview</li> <li>o Task Cost Overview</li> </ul> </li> <li>▪ <b>Progress Reports</b> <ul style="list-style-type: none"> <li>o Critical Tasks</li> <li>o Milestone Report</li> <li>o Slipping Tasks</li> </ul> </li> </ul> </li> </ul>

#### @The CO-PO Mapping Matrix (SPOS and IoT&ES)

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

#### @The CO-PO Mapping Matrix (SPOS and HCI)

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

#### @The CO-PO Mapping Matrix (SPOS and DS)

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

<b>CO5</b>	2	2	2	1	2	-	-	-	-	-	-	-
<b>CO6</b>	2	3	3	2	2	-	-	-	-	-	-	-
<b>@The CO-PO Mapping Matrix (SPOS and SPM)</b>												
<b>PO/CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	1	2	2	2	3	-	-	-	-	-	-	1
<b>CO2</b>	1	2	2	2	2	-	-	-	-	-	-	1
<b>CO3</b>	1	2	2	2	2	-	-	-	-	-	-	1
<b>CO4</b>	-	-	1	-	-	-	-	-	1	-	3	-
<b>CO5</b>	-	-	-	-	2	-	-	-	1	-	3	-
<b>CO6</b>	-	-	-	-	-	-	-	-	2	-	3	-

**SavitribaiPhule Pune University**  
**Third Year of Computer Engineering (2019 Course)**  
**310249: Seminar and Technical Communication**



Teaching Scheme Practical: <b>01 Hours/Week</b>	Credit Scheme <b>01</b>	Examination Scheme and Marks <b>Term Work: 50 Marks</b>
<b>Course Objectives:</b>		

- 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:** Analyze a latest topic of professional interest
- CO2:** Enhance technical writing skills
- CO3:** Identify an engineering problem, analyze it and propose a work plan to solve it
- CO4:** Communicate with professional technical presentation skills

**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.
- 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

**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

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

**Savitribai Phule Pune University**  
**Third Year of Engineering (2019 Course)**  
**310250: Audit Course 5**

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

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

- Written Test
- Demonstrations/ Practical Test
- Presentation or Report

#### **Audit Course 5 Options**

<b>Audit Course Code</b>	<b>Audit Course Title</b>
<b>AC5-I</b>	Cyber Security
<b>AC5-II</b>	Professional Ethics and Etiquette
<b>AC5-III</b>	MOOC- Learn New Skills
<b>AC5- IV</b>	Engineering Economics
<b>AC5-V</b>	Foreign Language (one of Japanese/ Spanish/ French/ German). Course contents for <b>Japanese (Module 3)</b> 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](http://www.unipune.ac.in/university_files/syllabi.htm)

## AC5-I: Cyber Security

**Prerequisites:** Computer Network and Security (310244)

**Course Objectives:**

- To motivate students for understanding the various scenarios of cybercrimes
- To increase awareness about the cybercrimes and ways to be more secure in online activities
- To learn about various methods and tools used in cybercrimes
- To analyze the system for various vulnerabilities

**Course Outcomes :** On completion of the course, learners will be able to

- CO 1:** Understand and classify various cybercrimes
- CO 2:** Understand how criminals plan for the cybercrimes
- CO 3:** Apply tools and methods used in cybercrime
- CO 4:** Analyze the examples of few case studies of cybercrimes

### Course Contents

1. **Introduction to Cybercrime:** Introduction, Cybercrime: Definition and Origins of the Word, Cybercrime and Information Security, Cybercriminals, Classifications of Cybercrimes, Cybercrime: The Legal Perspectives, Cybercrimes: An Indian Perspective.
2. **Cyber offenses: How Criminals Plan Them:** Introduction, How Criminals Plan the Attacks, Social Engineering, Cyberstalking, Cybercafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing.
3. **Tools and Methods Used in Cybercrime :** Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks (**Expected to cover the introduction to all these terms**).
4. **Cybercrime: Illustrations, Examples and Mini-Cases:** Introduction, Real-Life Examples, Mini-Cases, Illustrations of Financial Frauds in Cyber Domain, Digital Signature-Related Crime Scenarios, Digital Forensics Case Illustrations, Online Scams.

**Text Books :**

1. Nina Godbole, Sunit Belapure , “Cyber Security- Understanding Cyber Crimes”, Computer Forensics and Legal Perspectives, Wiely India Pvt.Ltd, ISBN- 978-81-265-2179-1
2. William Stallings, “Computer Security: Principles and Practices”, Pearson 6<sup>th</sup> Ed, ISBN 978-0-13-335469-0

**Reference Books :**

1. Berouz Forouzan, “Cryptography and Network Security”, TMH, 2 edition, ISBN -978-00-707-0208-0. 5.
2. Mark Merkow, “Information Security-Principles and Practices”, Pearson Ed., ISBN- 978-81-317-1288-7
3. CK Shyamala et el., “Cryptography and Security”, Wiley India Pvt. Ltd, ISBN-978-81-265-2285-9

### @The CO-PO Mapping Matrix

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

## AC5-II: Professional Ethics and Etiquettes

**Prerequisites:** Business Communication Skill

**Course Objectives:**

- To learn importance of ethics and the rules of good behavior for today's most common social and business situations
- To acquire basic knowledge of ethics to make informed ethical decisions when confronted with problems in the working environment
- To develop an understanding towards business etiquettes and the proper etiquette practices for different business scenarios
- To learn the etiquette requirements for meetings, entertaining, telephone, email and Internet business interaction scenario

**Course Outcomes:**

On completion of the course, learners will be able to

**CO1:** Summarize the principles of proper courtesy as they are practiced in the workplace

**CO2:** Apply proper courtesy in different professional situations

**CO3:** Practice and apply appropriate etiquettes in the working environment and day to day life

**CO4:** Build proper practices personal and business communications of Ethics and Etiquettes

### Course Contents

1. **Introduction to Ethics:** Basics, Difference Between Morals, Ethics, and Laws, Engineering Ethics: Purpose of Engineering Ethics-Professional and Professionalism, Professional Roles to be played by an Engineer, Uses of Ethical Theories, Professional Ethics, Development of Ethics.
2. **Professional Ethics:** IT Professional Ethics, Ethics in the Business World, Corporate Social Responsibility, Improving Corporate Ethics, Creating an Ethical Work Environment, Including Ethical Considerations in Decision Making, Ethics in Information Technology, Common Ethical issues for IT Users, Supporting the Ethical Practices of IT users.
3. **Business Etiquette:** ABC's of Etiquette, Developing a Culture of Excellence, The Role of Good Manners in Business, Enduring Words Making Introductions and Greeting People: Greeting Components, The Protocol of Shaking Hands, Introductions, Introductory Scenarios, Addressing Individuals Meeting and Board Room Protocol: Guidelines for Planning a Meeting, Guidelines for Attending a Meeting.
4. **Professional Etiquette:** Etiquette at Dining, Involuntary Awkward Actions, How to Network, Networking Etiquette, Public Relations Office(PRO)'s Etiquettes, Technology Etiquette : Phone Etiquette, Email Etiquette, Social Media Etiquette, Video Conferencing Etiquette, interview Etiquette, Dressing Etiquettes : for interview, offices and social functions.

**References Books:**

1. Ghillyer, "Business Ethics Now", 3rd Edition, McGraw-Hill.
2. George Reynolds, "Ethics in Information Technology", Cengage Learning, ISBN-10:1285197151.
3. Charles E Harris, Micheal J. Rabins, "Engineering Ethics", Cengage Learning, ISBN- 13:978-1133934684,4th Edition.

### @The CO-PO Mapping Matrix

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

### AC5-III: MOOC- Learn New Skills (Full stack Developer)

**Prerequisites:** Programming Skills

**Course Objectives:**

- To understand the fundamental concepts in designing web based applications and applying frontend and backend technologies
- To understand the fundamental concepts in applying database techniques in application
- To progress the student towards term "industry ready engineer"

**Course Outcomes:**

On completion of the course, learners will be able to

**CO1:** Design and develop web application using frontend and backend technologies.

**CO2:** Design and develop dynamic and scalable web applications

**CO3:** Develop server side scripts

**CO4:** Design and develop projects applying various database techniques

### Course Contents

Full stack Developer

1. HTML5
2. CSS3
3. Bootstrap
4. Vanilla JS (ES6+)
5. Flask or Django
6. Wagtail CMS
7. Node.js
8. MySQL
9. jQuery

**Team Projects:** Design and develop an e-commerce a dynamic, scalable and responsive web application. (Sample Project similar problem statements and be formulated).

**Reference Books:**

1. Laura Lemay, Rafe Colburn and Jennifer Kyrnin, "Mastering HTML, CSS & Javascript Web Publishing", SAMS, BPB Publications
2. DT Editorial Services " HTML 5 Black Book (Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP, jQuery)" 2Ed , Dreamtech Press.

### @The CO-PO Mapping Matrix

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
<b>CO1</b>	3	3	3	3	3	1	1	1	1	1	1	1
<b>CO2</b>	3	3	3	3	3	1	1	1	1	1	1	1
<b>CO3</b>	3	3	3	3	3	1	1	1	1	1	1	1
<b>CO4</b>	3	3	3	3	3	1	1	1	1	1	1	1

## AC5-IV: Engineering Economics

Engineering economics is one of the most practical subject matters in the engineering curriculum, but it is an always challenging, ever-changing discipline. Engineers are planners and builders. They are also problem solvers, manager, decision makers. Engineering economics touches of these activities.

### **Course Objectives:**

- To understand engineering economics and money management
- To understand financial project analysis
- To estimate project cost and apply for business
- To understand making financial decisions when acting as team member or manager in the engineering project

### **Course Outcomes:**

On completion of the course, learners will be able to

**CO1:** Understand economics, the cost money and management in engineering

**CO2:** Analyze business economics and engineering assets evaluation

**CO3:** Evaluate project cost and its elements for business

**CO4:** Develop financial statements and make business decisions

### **Course Contents**

- 1. Understanding money and its management:** Engineering Economic Decisions, Time value of money, Money management, Equivalence calculations.
- 2. Evaluating business and engineering assets:** Present worth analysis, Annual equivalence Analysis, Rate of Return Analysis, Benefit Cost Analysis.
- 3. Development project cash flow:** Accounting of Income Taxes, Project cash flow Analysis, Handling Project Uncertainty.
- 4. Special topics in Engineering Economics:** Replacement decisions, understanding financial statements.

### **Reference Books :**

1. Chan S Park, “Fundamentals of Engineering Economics”, Pearson, ISBN-13: 9780134870076
2. James Riggs, “Engineering Economics”, Tata McGraw-Hill, ISBN – 13: 9780070586703

### **@The CO-PO Mapping Matrix**

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

### AC5-V: Foreign Language ( Japanese ) Module 3

**Prerequisites:** We recommend that candidates should have previously completed AC3-V(210251) and AC4-V (210260)

**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, learners 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 little sister, Rice Fields, My Teacher, People who Exit and People who Enter.

**Reference Books :**

1. 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 (eBook)
2. Banno, Eri, Yoko Ikeda, et al. Genki I, “An Integrated Course in Elementary Japanese”, 2nd ed. Japan Times/Tsai Fong Books, 2011. ISBN: 9784789014403.
3. Anna Sato and Eriko Sato, “My First Japanese Kanji Book, Learning kanji the fun and easy way”, TUTTLE PUBLISHING, First Edition ISBN: 978-1-4629-1369-5 (eBook)

### @The CO-PO Mapping Matrix

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

# Semester VI

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****310251: Data Science and Big Data Analytics**

<b>Teaching Scheme:</b> <b>TH: 03</b> <b>Hours/Week</b>	<b>Credit: 03</b>	<b>Examination Scheme:</b> <b>Mid-Sem (TH) : 30 Marks</b> <b>End-Sem (TH): 70 Marks</b>
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**Prerequisites Courses:** Discrete Mathematics (210241), Database Management Systems (310341)

**Companion Course:** Data Science and Big Data Analytics Laboratory (310256)

**Course Objectives:**

- To understand the need of Data Science and Big Data
- To understand computational statistics in Data Science
- To study and understand the different technologies used for Big Data processing
- To understand and apply data modelling strategies
- To learn Data Analytics using Python programming
- To be conversant with advances in analytics

**Course Outcomes:**

After completion of the course, learners should be able to

**CO1:** Analyze needs and challenges for Data Science Big Data Analytics

**CO2:** Apply statistics for Big Data Analytics

**CO3:** Apply the lifecycle of Big Data analytics to real world problems

**CO4:** Implement Big 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**

<b>Unit I</b>	<b>Introduction to Data Science and Big Data</b>	<b>07 Hours</b>
Basics and need of Data Science and Big Data, Applications of Data Science, Data explosion, 5 V's of Big Data, Relationship between Data Science and Information Science, Business intelligence versus Data Science, Data Science Life Cycle, Data: Data Types, Data Collection. Need of Data wrangling, Methods: Data Cleaning, Data Integration, Data Reduction, Data Transformation, Data Discretization.		
<b>#Exemplar/Case Studies</b>	Create academic performance dataset of students and perform data pre-processing using techniques of data cleaning and data transformation.	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1	
<b>Unit II</b>	<b>Statistical Inference</b>	<b>07 Hours</b>
Need of statistics in Data Science and Big Data Analytics, <b>Measures of Central Tendency:</b> Mean, Median, Mode, Mid-range. <b>Measures of Dispersion:</b> 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.		
<b>#Exemplar/Case Studies</b>	For an employee dataset, create measure of central tendency and its measure of dispersion for statistical analysis of given data.	
<b>*Mapping of Course Outcomes for Unit II</b>	CO2	
<b>Unit III</b>	<b>Big Data Analytics Life Cycle</b>	<b>07 Hours</b>
Introduction to Big Data, sources of Big Data, <b>Data Analytic Lifecycle:</b> Introduction, Phase 1: Discovery, Phase 2: Data Preparation, Phase 3: Model Planning, Phase 4: Model Building, Phase 5: Communication results, Phase 6: Operationalize.		

<b>#Exemplar/Case Studies</b>	Case study: Global Innovation Social Network and Analysis (GINA).			
<b>*Mapping of Course Outcomes for Unit III</b>	CO3			
<b>Unit IV</b>	<b>Predictive Big Data Analytics with Python</b>	<b>07 Hours</b>		
<b>Introduction</b> , Essential Python Libraries, Basic examples. <b>Data Preprocessing</b> : Removing Duplicates, Transformation of Data using function or mapping, replacing values, Handling Missing Data. Analytics Types: Predictive, Descriptive and Prescriptive. <b>Association Rules</b> : Apriori Algorithm, FP growth. <b>Regression</b> : Linear Regression, Logistic Regression. <b>Classification</b> : Naïve Bayes, Decision Trees. <b>Introduction to Scikit-learn</b> , Installations, Dataset, matplotlib, filling missing values, Regression and Classification using Scikit-learn.				
<b>#Exemplar/Case Studies</b>	Use IRIS dataset from Scikit and apply data preprocessing methods			
<b>*Mapping of Course Outcomes for Unit IV</b>	CO4, CO2			
<b>Unit V</b>	<b>Big Data Analytics and Model Evaluation</b>	<b>07 Hours</b>		
<b>Clustering Algorithms</b> : K-Means, Hierarchical Clustering, Time-series analysis. <b>Introduction to Text Analysis</b> : Text-preprocessing, Bag of words, TF-IDF and topics. Need and Introduction to social network analysis, Introduction to business analysis. <b>Model Evaluation and Selection</b> : Metrics for Evaluating Classifier Performance, Holdout Method and Random Subsampling, Parameter Tuning and Optimization, Result Interpretation, Clustering and Time-series analysis using Scikit-learn, sklearn.metrics, Confusion matrix, AUC-ROC Curves, Elbow plot.				
<b>#Exemplar/Case Studies</b>	Use IRIS dataset from Scikit and apply K-means clustering methods			
<b>*Mapping of Course Outcomes for Unit V</b>	CO4, CO2			
<b>Unit VI</b>	<b>Data Visualization and Hadoop</b>	<b>07 Hours</b>		
Introduction to Data Visualization, Challenges to Big data visualization, Types of data visualization, Data Visualization Techniques, Visualizing Big Data, Tools used in Data Visualization, Hadoop ecosystem, Map Reduce, Pig, Hive, Analytical techniques used in Big data visualization. <b>Data Visualization using Python</b> : Line plot, Scatter plot, Histogram, Density plot, Box- plot.				
<b>#Exemplar/Case Studies</b>	Use IRIS dataset from Scikit and plot 2D views of the dataset			
<b>*Mapping of Course Outcomes for Unit VI</b>	CO5, CO6			
<b>Learning Resources</b>				
<b>Text Books:</b>				
<ol style="list-style-type: none"> <li>1. David Dietrich, Barry Hiller, “Data Science and Big Data Analytics”, EMC education services, Wiley publication, 2012, ISBN0-07-120413-X.</li> <li>2. Jiawei Han, Micheline Kamber, and Jian Pie, “Data Mining: Concepts and Techniques” Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807</li> </ol>				
<b>Reference Books :</b>				
<ol style="list-style-type: none"> <li>1. EMC Education Services, “Data Science and Big Data Analytics- Discovering, analyzing Visualizing and Presenting Data”</li> <li>2. DT Editorial Services, “Big Data, Black Book”, DT Editorial Services, ISBN: 9789351197577, 2016 Edition.</li> <li>3. Chirag Shah, “A Hands-On Introduction To Data Science”, Cambridge University Press, (2020), ISBN : ISBN 978-1-108-47244-9.</li> <li>4. Wes McKinney, “Python for Data Analysis” O’ Reilly media, ISBN: 978-1-449-31979-3.</li> <li>5. “Scikit-learn Cookbook”, Trent hauk,Packt Publishing, ISBN: 9781787286382</li> </ol>				

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|---|--|
| 6. Jenny Kim, Benjamin Bengfort, "Data Analytics with Hadoop", O'Reilly Media, Inc., ISBN: 9781491913703. | 7. Venkat Ankam, "Big Data Analytics", Packt Publishing, ISBN: 9781785884696 |
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**e-Books :**

- An Introduction to Statistical Learning by Gareth James  
<https://www.ime.unicamp.br/~dias/Intoduction%20to%20Statistical%20Learning.pdf>
- Python Data Science Handbook by Jake VanderPlas  
<https://tanhiamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf>
- Introducing Data Science by Davy Ciele, Manning Publications
- Introducing Data Science [PDF]
- Handbook for visualizing : a handbook for data driven design by Andy krik
- A Handbook for Data Driven Design
- An introduction to data Science :  
<https://docs.google.com/file/d/0B6iefdnF22XQeVZDSkxjZ0Z5VUE/edit?pli=1>
- 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](https://www.tutorialspoint.com/hadoop/hadoop_tutorial.pdf?utm_source=7_&utm_medium=affiliate&utm_content=5f34cd37cdf1050001b09537&utm_campaign=Admitad&utm_term=761c575424fc4a6b48d02f72157eb578)
- Learning with Python; How to think like a computer scientist:  
<http://openbookproject.net/thinkcs/python/english3e/>
- Python for everybody:  
[http://d01.dr-chuck.com/pythonlearn/EN\\_us/pythonlearn.pdf](http://d01.dr-chuck.com/pythonlearn/EN_us/pythonlearn.pdf)
- Scikit Learn Tutorial
- <https://scikit-learn.org/stable/>

**MOOCs Courses links:**

- Computer Science and Engineering - NOC:Data Science for Engineers
- Computer Science and Engineering - NOC:Python for Data Science
- Computer Science and Engineering - NOC:Data Mining
- Computer Science and Engineering - NOC:Big Data Computing
- Big Data Computing - Course

**@The CO-PO Mapping Matrix**

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

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****310252: Web Technology** [Home](#)**Teaching Scheme:****TH: 03****Hours/Week****Credit: 03****Examination Scheme:****Mid-Sem (TH) : 30 Marks****End-Sem (TH): 70 Marks**

**Prerequisites Courses:** Database Management Systems (310341),  
Computer Networks and Security (310244)

**Companion Course:** Web Technology Laboratory (310257)

**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**

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.

**#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**

**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.

**#Exemplar/Case Studies**

Enhancement in created blogging application using JavaScript (Add Entry feature)

**\*Mapping of Course Outcomes for Unit II**

CO2

<b>Unit III</b>	<b>Java Servlets and XML</b>	<b>07 Hours</b>
<b>Servlet:</b> 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. <b>XML:</b> XML documents and vocabularies, XML declaration, XML Namespaces, DOM based XML processing, transforming XML documents, DTD: Schema, elements, attributes. <b>AJAX:</b> Introduction, Working of AJAX.		
<b>#Exemplar/Case Studies</b>	Develop server-side code for blogging application	
<b>*Mapping of Course Outcomes for Unit III</b>	CO3	
<b>Unit IV</b>	<b>JSP and Web Services</b>	<b>07 Hours</b>
<b>JSP:</b> 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. <b>Web Services:</b> Web Service concepts, Writing a Java Web Service, Writing a Java web service client, Describing Web Services: WSDL, Communicating Object data: SOAP. <b>Struts:</b> Overview, architecture, configuration, actions, interceptors, result types, validations, localization, exception handling, annotations.		
<b>#Exemplar/Case Studies</b>	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	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO3, CO4	
<b>Unit V</b>	<b>Server Side Scripting Languages</b>	<b>07 Hours</b>
<b>PHP:</b> 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. <b>Introduction to ASP.NET:</b> Overview of the .NET Framework, Overview of C#, Introduction to ASP.NET, ASP.NET Controls, Web Services. Overview of Node JS.		
<b>#Exemplar/Case Studies</b>	Use of PHP in developing blogging application.	
<b>*Mapping of Course Outcomes for Unit V</b>	CO5, CO6	
<b>Unit VI</b>	<b>Ruby and Rails</b>	<b>07 Hours</b>
<b>Introduction to Ruby:</b> 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. <b>Introduction to Rails:</b> Overview of Rails, Document Requests, Processing Forms, Rails Applications and Databases, Layouts, Rails with Ajax. Introduction to EJB.		
<b>#Exemplar/Case Studies</b>	Study of dynamic web product development using ruby and rails	
<b>*Mapping of Course Outcomes for Unit VI</b>	CO6	
<b>Learning Resources</b>		
<b>Text Books:</b>		
<ol style="list-style-type: none"> <li>Jeffrey C.Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035.</li> </ol>		

2. 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/25> video 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](http://www.nptelvideos.com/php/php_video_tutorials.php)

#### **@ The CO-PO Mapping Matrix**

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

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****310253: Artificial Intelligence**[Home](#)**Teaching Scheme:****TH: 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:** Laboratory Practice II (310258)**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**

<b>Unit I</b>	<b>Introduction</b>	<b>07 Hours</b>
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.		
<b>#Exemplar/Case Studies</b>	Kroger: How This U.S. Retail Giant Is Using AI And Robots To Prepare For The 4th Industrial Revolution	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1, CO4	
<b>Unit II</b>	<b>Problem-solving</b>	<b>07 Hours</b>
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.		
<b>#Exemplar/Case Studies</b>	4th Industrial Revolution Using AI, Big Data And Robotics	
<b>*Mapping of Course Outcomes for Unit II</b>	CO2, CO4	

<b>Unit III</b>	<b>Adversarial Search and Games</b>	<b>07 Hours</b>
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.		
<b>#Exemplar/Case Studies</b>	Machine Learning At Google: The Amazing Use Case Of Becoming A Fully Sustainable Business	
<b>*Mapping of Course Outcomes for Unit III</b>	CO3, CO4	
<b>Unit IV</b>	<b>Knowledge</b>	<b>07 Hours</b>
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.		
<b>#Exemplar/Case Studies</b>	BBC To Launch AI - Enabled Interactive Radio Show For Amazon Echo And Google Home Chatbots	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO3, CO4	
<b>Unit V</b>	<b>Reasoning</b>	<b>07 Hours</b>
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		
<b>#Exemplar/Case Studies</b>	The Amazing Ways How Wikipedia Uses Artificial Intelligence	
<b>*Mapping of Course Outcomes for Unit V</b>	CO4, CO5	
<b>Unit VI</b>	<b>Planning</b>	<b>07 Hours</b>
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.		
<b>#Exemplar/Case Studies</b>	The Amazing Ways Samsung Is Using Big Data, Artificial Intelligence And Robots To Drive Performance	
<b>*Mapping of Course Outcomes for Unit VI</b>	CO4, CO6	
<b>Learning Resources</b>		
<b>Text Books:</b>		
<ol style="list-style-type: none"> <li>1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Third edition, Pearson, 2003, ISBN :10: 0136042597</li> <li>2. Deepak Khemani, “A First Course in Artificial Intelligence”, McGraw Hill Education(India), 2013, ISBN : 978-1-25-902998-1</li> <li>3. Elaine Rich, Kevin Knight and Nair, “Artificial Intelligence”, TMH, ISBN-978-0-07-008770-5</li> </ol>		

**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

**e-Books :**

- <https://cs.calvin.edu/courses/cs/344/kvlinden/resources/AIMA-3rd-edition.pdf>
- <https://www.cin.ufpe.br/~tf12/artificial-intelligence-modern-approach.9780131038059.25368.pdf>
- <http://aima.cs.berkeley.edu/>

**NPTEL video lecture 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**

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

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****Elective II****310254(A): Information Security****Teaching Scheme:****TH: 03****Hours/Week****Credit: 03****Examination Scheme:****Mid-Sem (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:** -- Computer Networks and Security (310244)**Companion Course:** -- Laboratory Practice II (310258)**Course Objectives:**

- To understand the fundamental approaches, principles and apply these concepts in Information Security
- To acquire the knowledge of mathematics for cryptography, understand the concepts of basic cryptography
- To learn standard algorithms and protocols employed to provide confidentiality, integrity and authenticity
- To acquire the knowledge of security protocol deployed in web security
- To study Information Security tools

**Course Outcomes:**

On completion of the course, learners should be able to

**CO1:** Model the cyber security threats and apply formal procedures to defend the attacks

**CO2:** Apply appropriate cryptographic techniques by learning symmetric and asymmetric key cryptography

**CO3:** Design and analyze web security solutions by deploying various cryptographic techniques along with data integrity algorithms

**CO4:** Identify and Evaluate Information Security threats and vulnerabilities in Information systems and apply security measures to real time scenarios

**CO5:** Demonstrate the use of standards and cyber laws to enhance Information Security in the development process and infrastructure protection

**Course Contents**

<b>Unit I</b>	<b>Introduction to Information Security</b>	<b>05 Hours</b>
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Foundations of Security, Computer Security Concepts, The OSI Security Architecture, Security attacks, Security services, Security mechanism, A Model for Network Security.

<b>#Exemplar/Case Studies</b>	Open Source/ Free/ Trial Tools: ClamAV antivirus engine, Anti Phishing, Anti Spyware, Wireshark
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<b>*Mapping of Course Outcomes for Unit I</b>	CO1
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<b>Unit II</b>	<b>Symmetric Key Cryptography</b>	<b>07 Hours</b>
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Classical Encryption Techniques: Stream Ciphers, Substitution Techniques: Caesar Cipher, Monoalphabetic Ciphers, Playfair Cipher, Hill Cipher, Polyalphabetic Ciphers, Transposition Techniques, Block Ciphers and Data Encryption standards, 3DES, Advanced Encryption standard

<b>#Exemplar/Case Studies</b>	Open Source/ Free/ Trial Tools: crypt tool
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<b>*Mapping of Course Outcomes for Unit II</b>	CO2
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<b>Unit III</b>	<b>Asymmetric Key Cryptography</b>	<b>07 Hours</b>
<b>Number theory:</b> Prime number, Fermat and Euler theorems , Testing for primality, Chinese remainder theorem, discrete logarithm, Public Key Cryptography and RSA, Diffie-Hellman key exchange, ElGamal algorithm, Elliptic Curve Cryptography		
<b>#Exemplar/Case Studies</b>	Open Source/ Free/ Trial Tools: crypt tool	
<b>*Mapping of Course Outcomes for Unit III</b>	CO2	
<b>Unit IV</b>	<b>Data Integrity Algorithms And Web Security</b>	<b>09 Hours</b>
<b>Cryptographic Hash Functions:</b> Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Requirements and Security, Hash Functions Based on Cipher Block Chaining, Secure Hash Algorithm (SHA), SHA-3, MD4, MD5. <b>Message Authentication Codes:</b> Message Authentication Requirements, Message Authentication Functions, Requirements for Message Authentication Codes, Security of MACs. <b>Digital Signatures:</b> Digital Signatures, Schemes, Digital Signature standard, X.509 Certificate. Web Security issues, HTTPS, SSH, Email security: PGP, S/MIME, IP Security : IPSec		
<b>#Exemplar/Case Studies</b>	Open Source/ Free/ Trial Tools: OpenSSL, Hash Calculator Tool : MD5, SHA1, SHA256, SHA 512	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO3	
<b>Unit V</b>	<b>Network and System Security</b>	<b>07 Hours</b>
The OSI Security architecture, Access Control, Flooding attacks, DOS, Distributed DOS attacks Intrusion detection, Host based and network based Honeypot, Firewall and Intrusion prevention system, Need of firewall, Firewall characteristics and access policy, Types of Firewall, DMZ networks, <b>Intrusion prevention system:</b> Host based, Network based, Hybrid. Operating system Security, Application Security, Security maintenance, Multilevel Security, Multilevel Security for role based access control, Concepts of trusted system, Trusted computing.		
<b>#Exemplar/Case Studies</b>	Open Source/ Free/ Trial Tools: DOS Attacks, DDOS attacks, Wireshark, Cain and Abel, iptables/ Windows Firewall, Suricata, fail2ban, Snort.	
<b>*Mapping of Course Outcomes for Unit V</b>	CO4	
<b>Unit VI</b>	<b>Cyber Security and Tools</b>	<b>07 Hours</b>
Introduction, Cybercrime and Information Security, Classification of Cybercrimes, The legal perspectives-Indian perspective, Global perspective, Categories of Cybercrime, Social Engineering, Cyber stalking, Proxy servers and Anonymizers, Phishing, Password Cracking, Key-loggers and Spywares, The Indian IT Act-Challenges, Amendments, Challenges to Indian Law and Cybercrime Scenario in India, Indian IT Act.		
<b>#Exemplar/Case Studies</b>	Study of any two network security scanners: Nmap, Metasploit, OpenVAS, Aircrack, Nikto, Samurai, Safe 3 etc.	
<b>*Mapping of Course Outcomes for Unit VI</b>	CO5	
<b>Learning Resources</b>		
<b>Text Books :</b> <ol style="list-style-type: none"> <li>1. William Stallings, Lawrie Brown, "Computer Security Principles and Practice", 3rd_Edition, Pearson , ISBN : 978-0-13-3777392-7</li> <li>2. William Stallings, "Cryptography and Network Security Principles and Practice", Seventh edition, Pearson , ISBN : 978-1-292-15858</li> </ol>		

- 3.** Nina Godbole, Sumit Belapure, "Cyber Security", Wiley, ISBN: 978-81-265-2179-1

#### Reference Books :

1. Atul Kahate, "Cryptography and Network Security", 3e, McGraw Hill Education
2. V.K. Pachghare, "Cryptography and Information Security", PHI Learning
3. Bernard Menezes, "Network Security and Cryptography", Cengage Learning India, 2014, ISBN No.: 8131513491
4. Josheph Kizza, "Computer Network Security and Cyber Ethics", McFarland & Company, Inc., Publishers , Fourth Edition
5. Michael Whitman and Herbert Matford, "Principles of Information Security", Course Technology Ink, 7th edition

#### e-Books :

- Introduction to Cyber Security, "<http://www.uou.ac.in/sites/default/files/slm/FCS.pdf>", by Dr.JeetendraPande | Uttarakhand Open University, Haldwani
- "Information Security, The complete reference", Second Edition, Mark Rhodes-Ousley, McGrawHill

#### MOOCs Courses link

- Introduction to cyber security, "[https://swayam.gov.in/nd2\\_nou19\\_cs08/preview](https://swayam.gov.in/nd2_nou19_cs08/preview)" by Dr. JeetendraPande | Uttarakhand Open University, Haldwani
- NPTEL course on <https://nptel.ac.in/courses/106/106/106106129/>(IIT Madras, Prof. V.Kamakoti)

#### @The CO-PO Mapping Matrix

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

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****Elective II****310254(B): Augmented and Virtual Reality****Teaching Scheme:****TH: 03****Hours/Week****Credit: 03****Examination Scheme:****Mid-Semester (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:** Computer Graphics (210244)**Companion Course:** Laboratory Practice II (310258)**Course Objectives:**

- To understand fundamentals of augmented and virtual reality
- To describe various elements and components used in AR/VR Hardware and Software
- To understand the methods used for representing and rendering the virtual world
- To create Augmented Reality application that allows users to interact with the immersive 3D world

**Course Outcomes:**

On completion of the course, learners should be able to

**CO1:** Understand the basics of Augmented and Virtual reality systems and list their applications

**CO2:** Describe interface to the Virtual World with the help of input and output devices

**CO3:** Explain representation and rendering system in the context of Virtual Reality

**CO4:** Analyze manipulation, navigation and interaction of elements in the virtual world

**CO5:** Summarize the basic concepts and hardware of Augmented Reality system

**CO6:** Create Mobile Augmented Reality using Augmented Reality techniques and software

**Course Contents****Unit I****Introduction****06 Hours**

**Virtual Reality (VR):** Introduction, Key Elements of VR, Experience, History, Applications.

**Augmented Reality (AR):** Introduction, History, Key Aspects, and Applications.

**#Exemplar/Case Studies**

Timeline of evolution of AR from VR and Case study of a single application using both VR and AR technologies

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

CO1

**Unit II****Interface to the Virtual World****08 Hours**

**Input:** User Monitoring, Position Tracking, Body Tracking, Physical input Devices, Speech Recognition (Audio Input) and World Monitoring: Persistent Virtual Worlds, Bringing the Real World into the Virtual World.

**Output:**

**Visual Displays :** Properties of Visual Displays, Monitor-based or Fishtank-VR, Projection-based VR, Head-based VR, See-through Head-based Displays, Handheld VR.

**Aural Displays :** Properties of Aural Displays, Head-based Aural Displays- Headphones, Stationary Aural Displays-Speakers.

**Haptic Displays:** Properties of Haptic Displays, Tactile Haptic Displays, End-effector Displays, Robotically Operated Shape Displays, Vestibular and Other Senses.

**#Exemplar/Case Studies**

Study the use of Virtual Reality at NASA

<b>*Mapping of Course Outcomes for Unit II</b>	CO2	
<b>Unit III</b>	<b>Representing and Rendering the Virtual World</b>	<b>08 Hours</b>
<b>Representation of the Virtual World:</b> Visual Representation in Virtual Reality, Aural Representation and Haptic Representation in Virtual Reality.		
<b>Rendering Systems:</b>		
<b>Visual Rendering Systems:</b> Visual Rendering Methods, Geometrically Based Rendering Systems, Non-geometric Rendering Systems, Rendering Complex Visual Scenes, Computer Graphics System Requirements.		
<b>Aural Rendering Systems:</b> Visual Rendering Methods, Rendering Complex Sounds, Sound-Generation Hardware, Internal Computer Representation.		
<b>Haptic Rendering Systems :</b> Haptic Rendering Methods, Rendering Complex Haptic Scenes with Force Displays, Haptic Rendering Techniques.		
<b>#Exemplar/Case Studies</b>	GHOST (General Haptics Open Software Toolkit) software development toolkit.	
<b>*Mapping of Course Outcomes for Unit III</b>	CO3	
<b>Unit IV</b>	<b>Interacting with the Virtual World and Virtual Reality Experience</b>	<b>07 Hours</b>
User Interface Metaphors, Manipulating a Virtual World, Properties of Manipulation, Manipulation Operations, Navigating in a Virtual World-Way finding and Travelling, Classes of Travel Methods Interacting with Others-Shared Experience, Collaborative Interaction, Interacting with the VR System, Immersion, Rules of the Virtual World: Physics, Substance of the Virtual World.		
<b>#Exemplar/Case Studies</b>	Side effects of using VR systems/ VR sickness and Study of Iterative design of any VR game.	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO4	
<b>Unit V</b>	<b>Augmented Reality</b>	<b>06 Hours</b>
<b>Concepts:</b> Computer Graphics, Dimensionality, Depth Cues, Registration and Latency, Working of Augmented Reality, Augmented Reality Hardware (Sensors, Processors, Displays), Ingredients of an AR Experience.		
<b>#Exemplar/Case Studies</b>	Augmented Reality (AR) and Virtual Reality (VR) headsets mainly find applications in gaming, movies, and other forms of entertainment. French startup Lynx has manufactured a standalone Mixed Reality (MR) headset for entertainment, medical, industrial, and defense applications. Analyze the technical specifications of Lynx – Mixed Reality Headset	
<b>*Mapping of Course Outcomes for Unit V</b>	CO1, CO5	
<b>Unit VI</b>	<b>Augmented Reality Software and Mobile Augmented Reality</b>	<b>07 Hours</b>
Augmented Reality Systems, Software Components, Software Tools for Content Creation, Interaction in Augmented Reality, <b>Augmented Reality Techniques:</b> Marker based and Markerless tracking, Mobile Augmented Reality.		

#Exemplar/Case Studies	Case study of Google Maps AR navigation and its use
*Mapping of Course Outcomes for Unit VI	CO6

### Learning Resources

**Text Books :**

1. William R Sherman and Alan B Craig, "Understanding Virtual Reality: Interface, Application and Design", (The Morgan Kaufmann Series in Computer Graphics)", Morgan Kaufmann Publishers, San Francisco, CA, 2002
2. Alan B Craig, "Understanding Augmented Reality, Concepts and Applications", Morgan Kaufmann Publishers, ISBN:978-0240824086

**Reference Books :**

1. Steven M. LaValle, "Virtual Reality", Cambridge University Press, 2016
2. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann, 2009.
3. Schmalstieg / Hollerer, "Augmented Reality: Principles & Practice", Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
4. Sanni Siltanen, "Theory and applications of marker-based augmented reality", Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0

**e-Books :**

- <http://lavalle.pl/vr/book.html>
- <https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf>

**MOOC Courses link:**

- <https://nptel.ac.in/courses/106/106/106106138/>
- <https://www.coursera.org/learn/introduction-virtual-reality>
- <https://www.coursera.org/learn/ar>

### @The CO-PO Mapping Matrix

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

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****Elective II****310254(C): Cloud Computing** Home**Teaching Scheme:****TH: 03****Hours/Week****Credit: 03****Examination Scheme:****Mid-Semester (TH) : 30 Marks****End-Sem (TH): 70 Marks****Prerequisites Courses:** Computer Networks and Security (310244),

Distributed System (310245C)

**Companion Course:** Laboratory Practice II (310258)**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**

<b>Unit I</b>	<b>Introduction to Cloud Computing</b>	<b>07 Hours</b>
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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.

<b>#Exemplar/Case Studies</b>	Cloud Computing Model of IBM
<b>*Mapping of Course Outcomes for Unit I</b>	CO1

<b>Unit II</b>	<b>Data Storage and Cloud Computing</b>	<b>07 Hours</b>
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**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.

<b>#Exemplar/Case Studies</b>	Online Book Marketing Service, Online Photo Editing Service
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<b>*Mapping of Course Outcomes for Unit II</b>	CO2	
<b>Unit III</b>	<b>Virtualization in Cloud Computing</b>	<b>07 Hours</b>
<b>Introduction:</b> Definition of Virtualization, Adopting Virtualization, Types of Virtualization, Virtualization Architecture and Software, Virtual Clustering, Virtualization Application, Pitfalls of Virtualization. <b>Grid, Cloud and Virtualization:</b> Virtualization in Grid, Virtualization in Cloud, Virtualization and Cloud Security. <b>Virtualization and Cloud Computing:</b> Anatomy of Cloud Infrastructure, Virtual infrastructures, CPU Virtualization, Network and Storage Virtualization.		
<b>#Exemplar/Case Studies</b>	Xen: Paravirtualization, VMware: Full Virtualization, Microsoft Hyper-V	
<b>*Mapping of Course Outcomes for Unit III</b>	CO3	
<b>Unit IV</b>	<b>Cloud Platforms and Cloud Applications</b>	<b>07 Hours</b>
<b>Amazon Web Services (AWS):</b> Amazon Web Services and Components, Amazon Simple DB, Elastic Cloud Computing (EC2), Amazon Storage System, Amazon Database services (Dynamo DB). <b>Microsoft Cloud Services:</b> Azure core concepts, SQL Azure, Windows Azure Platform Appliance. <b>Cloud Computing Applications:</b> 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.		
<b>#Exemplar/Case Studies</b>	Multiplayer Online Gaming	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO4	
<b>Unit V</b>	<b>Security in Cloud Computing</b>	<b>07 Hours</b>
<b>Risks in Cloud Computing:</b> Risk Management, Enterprise-Wide Risk Management, Types of Risks in Cloud Computing. <b>Data Security in Cloud:</b> Security Issues, Challenges, advantages, Disadvantages, Cloud Digital persona and Data security, Content Level Security. <b>Cloud Security Services:</b> Confidentiality, Integrity and Availability, Security Authorization Challenges in the Cloud, Secure Cloud Software Requirements, Secure Cloud Software Testing.		
<b>#Exemplar/Case Studies</b>	Cloud Security Tool: Acunetix.	
<b>*Mapping of Course Outcomes for Unit V</b>	CO5	
<b>Unit VI</b>	<b>Advanced Techniques in Cloud Computing</b>	<b>07 Hours</b>
<b>Future Trends in cloud Computing, Mobile Cloud,</b> <b>Automatic Cloud Computing:</b> Comet Cloud. <b>Multimedia Cloud:</b> IPTV, Energy Aware Cloud Computing, Jungle Computing, Distributed Cloud Computing Vs Edge Computing, Containers, Docker, and Kubernetes, Introduction to DevOps. <b>IOT and Cloud Convergence:</b> The Cloud and IoT in your Home, The IOT and cloud in your Automobile, PERSONAL: IoT in Healthcare.		
<b>#Exemplar/Case Studies</b>	Case studies on DevOps: DocuSign, Forter, Gengo.	
<b>*Mapping of Course Outcomes for Unit VI</b>	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", O'reilly, ISBN-13 978-81-8404-815-5

**e-Books :**

- <https://sjceodisha.in/wp-content/uploads/2019/09/CLOUD-COMPUTING-Principles-and-Paradigms.pdf>
- <https://studymt.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 Computing [https://onlinecourses.nptel.ac.in/noc21\\_cs14/preview?](https://onlinecourses.nptel.ac.in/noc21_cs14/preview?)
- Cloud Computing and Distributed System:  
[https://onlinecourses.nptel.ac.in/noc21\\_cs15/preview?](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

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

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****Elective II****310254(D): Software Modelling and Architecture** Home**Teaching Scheme:****TH: 03****Hours/Week****Credit: 03****Examination Scheme:****Mid-Semester (TH) : 30 Marks****End-Sem (TH): 70 Marks**

**Prerequisites Courses:** Object Oriented Programming (210243),  
Software Engineering (210253)

**Companion Course:** Laboratory Practice II (310258)

**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**

<b>Unit I</b>	<b>Concepts of Software Modelling</b>	<b>07 Hours</b>
<b>Software Modelling:</b> Introduction to Software Modelling, Advantages of modelling, Principles of modelling. <b>Evolution of Software Modeling and Design Methods:</b> 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. <b>Requirement Study:</b> Requirement Analysis, SRS design, Requirements Modeling. <b>Use Case:</b> Actor and Use case identification, Use case relationship (Include, Extend, Use case Generalization, Actor Generalization), Use case template.		
<b>#Exemplar/Case Studies</b>	Requirement modelling and use case modelling for Real life applications (e.g., Online shopping system)	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1, CO2	
<b>Unit II</b>	<b>Static Modelling</b>	<b>07 Hours</b>
Study of classes (analysis level and design level classes). <b>Methods for identification of classes:</b> RUP (Rational Unified Process), CRC (Class, Responsibilities and Collaboration), Use of Noun Verb analysis (for identifying entity classes, controller classes and boundary classes). <b>Class Diagram:</b> Relationship between classes, Generalization/Specialization Hierarchy, Composition and Aggregation Hierarchies, Associations Classes, Constraints.		

Object diagram, Package diagram, Component diagram, Composite Structure diagram, Deployment Diagram.

<b>#Exemplar/Case Studies</b>	UML Static Diagrams for Real life applications (e.g., Online shopping system).
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<b>*Mapping of Course Outcomes for Unit II</b>	CO1 ,CO2
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<b>Unit III</b>	<b>Dynamic Modelling</b>	<b>07 Hours</b>
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**Activity diagram:** Different Types of nodes, Control flow, Activity Partition, Exception handler, Interruptible activity region, Input and output parameters, Pins.

**Interaction diagram:** Sequence diagram, Interaction Overview diagram, State machine diagram, Advanced State Machine diagram, Communication diagram, Timing diagram.

<b>#Exemplar/Case Studies</b>	UML dynamic Diagrams of for Real life applications.
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<b>*Mapping of Course Outcomes for Unit III</b>	CO1 ,CO2
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<b>Unit IV</b>	<b>Software Architecture and Quality Attributes</b>	<b>07 Hours</b>
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Introduction to Software Architecture, Importance of Software Architecture, Architectural Structure and Views. **Architectural Pattern:** common module, Common component-and-connector, Common allocation.

**Quality Attributes:** Architecture and Requirements, Quality Attributes and Considerations

<b>#Exemplar/Case Studies</b>	Case study of any real-life application
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<b>*Mapping of Course Outcomes for Unit IV</b>	CO3
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<b>Unit V</b>	<b>Architectural Design and Documentation</b>	<b>07 Hours</b>
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**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.

<b>#Exemplar/Case Studies</b>	Air Traffic Control.
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<b>*Mapping of Course Outcomes for Unit V</b>	CO4 , CO5
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<b>Unit VI</b>	<b>Design Patterns</b>	<b>07 Hours</b>
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**Design Patterns:** Introduction, Different approaches to select Design Patterns. **Creational patterns:** Singleton, Factory, Structural pattern: Adapter, Proxy. **Behavioral Patterns:** Iterator, Observer Pattern with applications.

<b>#Exemplar/Case Studies</b>	Flight Simulation
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<b>*Mapping of Course Outcomes for Unit VI</b>	CO4, CO5
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### 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. 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. Grady 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_cs59/preview)
- [https://onlinecourses.nptel.ac.in/noc20\\_cs84/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 Computer Engineering (2019 Course)****310255: Internship\*\*** Home**Teaching Scheme:  
\*\*****Credit: 04****Examination Scheme:****Term work: 100 Marks****Course Objectives:**

Internship provides an excellent opportunity to learner to see how the conceptual aspects learned in classes are integrated into the practical world. Industry/on project experience provides much more professional experience as value addition to classroom teaching.

- To encourage and provide opportunities for students to get professional/personal experience through internships.
- To learn and understand real life/industrial situations.
- To get familiar with various tools and technologies used in industries and their applications.
- To nurture 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 internships to complete academic activities in a professional manner.

**CO3:** To choose appropriate technology and tools to solve given problem.

**CO4:** To demonstrate abilities of a responsible professional and use ethical practices in day to day life.

**CO5:** Creating network and social circle, and developing relationships with industry people.

**CO6:** To analyze various career opportunities and decide carrier goals.

**\*\* Guidelines:**

Internships are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important as the employers are looking for employees who are properly skilled and having awareness about industry environment, practices and culture. Internship is structured, short-term, supervised training often focused around particular tasks or projects with defined time scales.

Core objective is to expose technical students to the industrial environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry and to understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

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.

**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:**

Student may choose to undergo Internship at Industry/Govt. Organizations/NGO/MSME/Rural Internship/ Innovation/IPR/Entrepreneurship. Student may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship 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 from college authority well in advance. Internship work identification process should be initiated in the Vth semester in coordination with training and placement cell/ industry institute cell/ internship cell. This will help students to start their internship work on time. Also, it will allow students to work in vacation period after their Vth semester examination and before academic schedule of semester VI. Student can take internship work in the form of the following but not limited to:

Working for consultancy/ research project,

Contribution in Incubation/ Innovation/ Entrepreneurship Cell/ Institutional Innovation Council/ startups cells of institute /

Learning at 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 internship,

Participate in open source development.

### **Internship Diary/ Internship Workbook:**

Students must maintain Internship Diary/ Internship Workbook. The main purpose of maintaining 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 to the Institute immediately after the completion of the training.

### **Internship Work Evaluation:**

Every student is required to prepare a maintain documentary proofs of the activities done by him as internship diary or as workbook. The evaluation of these activities will be done by Programme Head/Cell In-charge/ Project Head/ faculty mentor or Industry Supervisor based on- Overall compilation of internship activities, sub-activities, the level of achievement expected, evidence needed to assign the points and the duration for certain activities.

Assessment and Evaluation is to be done in consultation with internship supervisor (Internal and External – a supervisor from place of internship).

### **Recommended evaluation parameters-Post Internship Internal Evaluation -50 Marks + Internship Diary/Workbook and Internship Report - 50 Marks**

#### **Evaluation through Seminar Presentation/Viva-Voce at the Institute-**

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

Depth of knowledge and skills: Communication and Presentation Skills  
Team Work  
Creativity  
Planning and Organizational skills  
Adaptability  
Analytical Skills  
Attitude and Behavior at work  
Societal Understanding  
Ethics  
Regularity and punctuality  
Attendance record  
Diary/Work book  
Student's Feedback from External Internship Supervisor

After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period.

Internship Diary/workbook may be evaluated on the basis of the following criteria:

Proper and timely documented entries  
Adequacy & quality of information recorded  
Data recorded  
Thought process and recording techniques used  
Organization of the information

The report shall be presented covering 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

Results / Analysis /inferences and conclusion

Suggestions / Recommendations for improvement to industry, if any

Attendance Record

Acknowledgement

List of reference (Library books, magazines and other sources)

### **Feedback from internship supervisor(External and Internal)**

Post internship, faculty coordinator should collect feedback about student with following recommended parameters-

Technical knowledge, Discipline, Punctuality, Commitment, Willingness to do the work, Communication skill, individual work, Team work, Leadership.....

Reference:

[1] <https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf>

[2] <https://internship.aicte-india.org/>

**@The CO-PO Mapping Matrix**

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<b>CO1</b>	2	2	2	2	3	1	1	1	1	2	1	1
<b>CO2</b>	1	2	2	2	3	2	1	1	1	2	2	1
<b>CO3</b>	-	-	-	-	-	1	-	-	2	2	1	1
<b>CO4</b>	2	-	-	-	-	2	2	3	-	1	-	2
<b>CO5</b>	-	-	-	-	-	1	2	1	1	1	2	1
<b>CO6</b>	-	-	-	-	-	1	-	-	2	1	-	1

**Savitribai Phule Pune University****Third Year of Computer Engineering (2019 Course)****310256: Data Science and Big Data Analytics Laboratory** Home**Teaching Scheme****Practical: 04 Hours/Week****Credit Scheme:****02****Examination Scheme and Marks****Term work: 50 Marks****Practical: 25 Marks****Companion Course:** Data Science and Big Data Analytics (310251)**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 Big 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 Big 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 Big 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, punctuality and

**Guidelines for Practical Examination**

Problem statements must be decided jointly by the internal examiner and external examiner. During practical assessment, maximum weightage should be given to satisfactory implementation of the problem statement. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals, effective and efficient implementation. This will encourage, transparent evaluation and fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.

## Guidelines for Laboratory Conduction

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

**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>

### **Suggested List of Laboratory Experiments/Assignments**

**Assignments from all Groups (A,B,C) are compulsory.**

Sr. No.	Group A : Data Science
1.	<p><b>Data Wrangling, I</b></p> <p>Perform the following operations using Python on any open source dataset (e.g., data.csv)</p> <ol style="list-style-type: none"> <li>1. Import all the required Python Libraries.</li> <li>2. Locate an open source data from the web (e.g., <a href="https://www.kaggle.com">https://www.kaggle.com</a>). Provide a clear description of the data and its source (i.e., URL of the web site).</li> <li>3. Load the Dataset into pandas dataframe.</li> <li>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.</li> <li>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.</li> <li>6. Turn categorical variables into quantitative variables in Python.</li> </ol> <p>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.</p>
2.	<p><b>Data Wrangling II</b></p> <p>Create an “Academic performance” dataset of students and perform the following operations using Python.</p> <ol style="list-style-type: none"> <li>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.</li> <li>2. Scan all numeric variables for outliers. If there are outliers, use any of the suitable techniques to deal with them.</li> <li>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.</li> </ol> <p>Reason and document your approach properly.</p>

3.	<p><b>Descriptive Statistics - Measures of Central Tendency and variability</b></p> <p>Perform the following operations on any open source dataset (e.g., data.csv)</p> <ol style="list-style-type: none"> <li>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.</li> <li>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.</li> </ol> <p>Provide the codes with outputs and explain everything that you do in this step.</p>
4.	<p><b>Data Analytics I</b></p> <p>Create a Linear Regression Model using Python/R to predict home prices using Boston Housing Dataset (<a href="https://www.kaggle.com/c/boston-housing">https://www.kaggle.com/c/boston-housing</a>). 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.</p> <p>The objective is to predict the value of prices of the house using the given features.</p>
5.	<p><b>Data Analytics II</b></p> <ol style="list-style-type: none"> <li>1. Implement logistic regression using Python/R to perform classification on Social_Network_Ads.csv dataset.</li> <li>2. Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given dataset.</li> </ol>
6.	<p><b>Data Analytics III</b></p> <ol style="list-style-type: none"> <li>1. Implement Simple Naïve Bayes classification algorithm using Python/R on iris.csv dataset.</li> <li>2. Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given dataset.</li> </ol>
7.	<p><b>Text Analytics</b></p> <ol style="list-style-type: none"> <li>1. Extract Sample document and apply following document preprocessing methods: Tokenization, POS Tagging, stop words removal, Stemming and Lemmatization.</li> <li>2. Create representation of document by calculating Term Frequency and Inverse Document Frequency.</li> </ol>
8.	<p><b>Data Visualization I</b></p> <ol style="list-style-type: none"> <li>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.</li> <li>2. Write a code to check how the price of the ticket (column name: 'fare') for each passenger is distributed by plotting a histogram.</li> </ol>
9.	<p><b>Data Visualization II</b></p> <ol style="list-style-type: none"> <li>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')</li> <li>2. Write observations on the inference from the above statistics.</li> </ol>

<p><b>10. Data Visualization III</b></p> <p>Download the Iris flower dataset or any other dataset into a DataFrame. (e.g., <a href="https://archive.ics.uci.edu/ml/datasets/Iris">https://archive.ics.uci.edu/ml/datasets/Iris</a>). Scan the dataset and give the inference as:</p> <ol style="list-style-type: none"> <li>1. List down the features and their types (e.g., numeric, nominal) available in the dataset.</li> <li>2. Create a histogram for each feature in the dataset to illustrate the feature distributions.</li> <li>3. Create a boxplot for each feature in the dataset.</li> <li>4. Compare distributions and identify outliers.</li> </ol>
<b>Group B- Big Data Analytics – JAVA/SCALA (Any three)</b>
<p>1. Write a code in JAVA for a simple WordCount application that counts the number of occurrences of each word in a given input set using the Hadoop MapReduce framework on local-standalone set-up.</p> <p>2. Design a distributed application using MapReduce which processes a log file of a system.</p> <p>3. Locate dataset (e.g., sample_weather.txt) for working on weather data which reads the text input files and finds average for temperature, dew point and wind speed.</p> <p>4. Write a simple program in SCALA using Apache Spark framework</p>
<b>Group C- Mini Projects/ Case Study – PYTHON/R (Any TWO Mini Project)</b>
<p>1. Write a case study on Global Innovation Network and Analysis (GINA). Components of analytic plan are 1. Discovery business problem framed, 2. Data, 3. Model planning analytic technique and 4. Results and Key findings.</p> <p>2. Use the following dataset and classify tweets into positive and negative tweets.  <a href="https://www.kaggle.com/ruchi798/data-science-tweets">https://www.kaggle.com/ruchi798/data-science-tweets</a></p> <p>3. Develop a movie recommendation model using the scikit-learn library in python.  Refer dataset  <a href="https://github.com/rashida048/Some-NLP-Projects/blob/master/movie_dataset.csv">https://github.com/rashida048/Some-NLP-Projects/blob/master/movie_dataset.csv</a></p> <p>4. Use the following covid_vaccine_statewise.csv dataset and perform following analytics on the given dataset  <a href="https://www.kaggle.com/sudalairajkumar/covid19-in-india?select=covid_vaccine_statewise.csv">https://www.kaggle.com/sudalairajkumar/covid19-in-india?select=covid_vaccine_statewise.csv</a></p> <p>a. Describe the dataset</p> <p>b. Number of persons state wise vaccinated for first dose in India</p> <p>c. Number of persons state wise vaccinated for second dose in India</p> <p>d. Number of Males vaccinated</p> <p>d. Number of females vaccinated</p> <p>5. Write a case study to process data driven for Digital Marketing <b>OR</b> Health care systems with Hadoop Ecosystem components as shown. (Mandatory)</p> <ul style="list-style-type: none"> <li>● HDFS: Hadoop Distributed File System</li> <li>● YARN: Yet Another Resource Negotiator</li> <li>● MapReduce: Programming based Data Processing</li> <li>● Spark: In-Memory data processing</li> <li>● PIG, HIVE: Query based processing of data services</li> <li>● HBase: NoSQL Database (Provides real-time reads and writes)</li> <li>● Mahout, Spark MLlib: (Provides analytical tools) Machine Learning algorithm libraries</li> <li>● Solar, Lucene: Searching and Indexing</li> </ul>

**Reference Books :**

1. Chirag Shah, "A Hands-On Introduction To Data Science", Cambridge University Press,(2020), ISBN : ISBN 978-1-108-47244-9.
2. Wes McKinney, "Python for Data Analysis", 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. Jenny Kim, Benjamin Bengfort, "Data Analytics with Hadoop", O'Reilly Media, Inc.
6. Jake VanderPlas, "Python Data Science Handbook"  
<https://tanthiamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf>
7. Gareth James, "An Introduction to Statistical Learning"  
<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. Alvin Alexander, "Scala Cookbook", 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://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/>

**MOOCs Courses link:**

- <https://nptel.ac.in/courses/106/106/106106212/>
- [https://onlinecourses.nptel.ac.in/noc21\\_cs33/preview](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://onlinecourses.nptel.ac.in/noc20_cs92/preview)

**@The CO-PO Mapping Matrix**

<b>PO/CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO1</b>	2	2	2	2	2	2	-	-	-	-	3	-
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<b>CO3</b>	2	2	2	-	2	-	-	-	-	-	-	-
<b>CO4</b>	2	2	2	2	2	2	-	-	-	-	-	-
<b>CO5</b>	2	2	2	2	2	2	-	-	-	-	-	-
<b>CO6</b>	2	2	2	2	2	2	-	-	-	-	-	-
<b>CO7</b>	2	2	2	2	3	2	-	-	-	-	-	-
<b>CO8</b>	2	2	2	2	3	2	-	-	-	-	3	-

**Savitribai Phule Pune University**  
**Third Year of Computer Engineering (2019 Course)**  
**310257: Web Technology Laboratory**


  
Home

Teaching Scheme <b>Practical: 02 Hours/Week</b>	Credit Scheme <b>01</b>	Examination Scheme and Marks <b>Term Work: 25 Marks</b> <b>Oral: 25 Marks</b>
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**Companion Course :** Web Technology (310252)

**Course Objectives:**

- To learn the web based development environment
- To use client side and server side web technologies
- To design and develop web applications using front end technologies and backend databases

**Course Outcomes:**

On completion of the course, learners will be able to

- CO1:** Understand the importance of website planning and website design issues  
**CO2:** Apply the client side and server side technologies for web application development  
**CO3:** Analyze the web technology languages, frameworks and services  
**CO4:** Create three tier web based applications

**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 Oral Examination**

Oral examination should be jointly conducted by the internal examiner and external examiner. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals, effective and efficient implementations in term work. 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. Mini project should be implemented by

the students in a group of 2-3 students.

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

Sr. No.	<b>Assignment Title</b>																	
Sr. No.	Website URL	Purpose of Website	Things liked in the website	Things disliked in the website	Overall evaluation of the website (Good/Bad)													
1.	<p>Case study: Before coding of the website, planning is important, students should visit different websites (Min. 5) for the different client projects and note down the evaluation results for these websites, either good website or bad website in following format:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;">Sr. No.</th><th style="width: 15%;">Website URL</th><th style="width: 15%;">Purpose of Website</th><th style="width: 15%;">Things liked in the website</th><th style="width: 15%;">Things disliked in the website</th><th style="width: 15%;">Overall evaluation of the website (Good/Bad)</th></tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table> <p>From the evaluation, students should learn and conclude different website design issues, which should be considered while developing a website.</p>						Sr. No.	Website URL	Purpose of Website	Things liked in the website	Things disliked in the website	Overall evaluation of the website (Good/Bad)						
Sr. No.	Website URL	Purpose of Website	Things liked in the website	Things disliked in the website	Overall evaluation of the website (Good/Bad)													
2.	<p>Implement a web page index.htm for any client website (e.g., a restaurant website project) using following:</p> <ul style="list-style-type: none"> <li>a. HTML syntax: heading tags, basic tags and attributes, frames, tables, images, lists, links for text and images, forms etc.</li> <li>b. Use of Internal CSS, Inline CSS, External CSS</li> </ul>																	
3.	<p>Design the XML document to store the information of the employees of any business organization and demonstrate the use of:</p> <ul style="list-style-type: none"> <li>a) DTD</li> <li>b) XML Schema</li> </ul> <p>And display the content in (e.g., tabular format) by using CSS/XSL.</p>																	
4.	<p>Implement an application in Java Script using following:</p> <ul style="list-style-type: none"> <li>a) Design UI of application using HTML, CSS etc.</li> <li>b) Include Java script validation</li> <li>c) Use of prompt and alert window using Java Script</li> </ul> <p>e.g., Design and implement a simple calculator using Java Script for operations like addition, multiplication, subtraction, division, square of number etc.</p> <ul style="list-style-type: none"> <li>a) Design calculator interface like text field for input and output, buttons for numbers and operators etc.</li> <li>b) Validate input values</li> <li>c) Prompt/alerts for invalid values etc.</li> </ul>																	
5.	<p>Implement the sample program demonstrating the use of Servlet.</p> <p>e.g., Create a database table ebookshop (book_id, book_title, book_author, book_price, quantity) using database like Oracle/MySQL etc. and display (use SQL select query) the table content using servlet.</p>																	
6.	<p>Implement the program demonstrating the use of JSP.</p> <p>e.g., Create a database table students_info (stud_id, stud_name, class, division, city) using database like Oracle/MySQL etc. and display (use SQL select query) the table content using JSP.</p>																	
7.	<p>Build a dynamic web application using PHP and MySQL.</p> <ul style="list-style-type: none"> <li>a. Create database tables in MySQL and create connection with PHP.</li> <li>b. Create the add, update, delete and retrieve functions in the PHP web app interacting with MySQL database</li> </ul>																	

	8.	Design a login page with entries for name, mobile number email id and login button. Use struts and perform following validations <ul style="list-style-type: none"> <li>a. Validation for correct names</li> <li>b. Validation for mobile numbers</li> <li>c. Validation for email id</li> <li>d. Validation if no entered any value</li> <li>e. Re-display for wrongly entered values with message</li> <li>f. Congratulations and welcome page upon successful entries</li> </ul>
	9.	Design an application using Angular JS.  e.g., Design registration (first name, last name, username, password) and login page using Angular JS.
	10.	Design and implement a business interface with necessary business logic for any web application using EJB.  e.g., Design and implement the web application logic for deposit and withdraw amount transactions using EJB.
	11.	<b>Mini Project:</b> Design and implement a dynamic web application for any business functionality by using web development technologies that you have learnt in the above given assignments.

### @The CO-PO Mapping Matrix

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

**SavitribaiPhule Pune University****Third Year of Computer Engineering (2019 Course)****310258: Laboratory Practice II** Home**Teaching Scheme  
Practical: 04 Hours/Week****Credit Scheme  
02****Examination Scheme and Marks  
Term Work: 50 Marks  
Practical: 25 Marks****Companion Course:** Artificial Intelligence (310253), Elective II (310245)**Course Objectives:**

- To learn and apply various search strategies for AI
- To Formalize and implement constraints in search problems
- To understand the concepts of Information Security / Augmented and Virtual Reality/Cloud Computing/Software Modeling and Architectures

**Course Outcomes:**

On completion of the course, learner will be able to

- **Artificial Intelligence**

**CO1:** Design system using different informed search / uninformed search or heuristic approaches

**CO2:** Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning

**CO3:** Design and develop an expert system

- **Information Security**

**CO4:** Use tools and techniques in the area of Information Security

**CO5:** Use the knowledge of security for problem solving

**CO6:** Apply the concepts of Information Security to design and develop applications

**OR**

- **Augmented and Virtual Reality**

**CO4:** Use tools and techniques in the area of Augmented and Virtual Reality

**CO5:** Use the knowledge of Augmented and Virtual Reality for problem solving

**CO6:** Apply the concepts of Augmented and Virtual Reality to design and develop applications

**OR**

- **Cloud Computing**

**CO4:** Use tools and techniques in the area of Cloud Computing

**CO5:** Use the knowledge of Cloud Computing for problem solving

**CO6:** Apply the concepts Cloud Computing to design and develop applications

**OR**

- **Software Modeling and Architectures**

**CO4:** Use tools and techniques in the area Software Modeling and Architectures

**CO5:** Use the knowledge of Software Modeling and Architectures for problem solving

**CO6:** Apply the concepts Software Modeling and Architectures to design and develop applications

**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.

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### **Guidelines for Laboratory /Term Work Assessment**

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### **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.

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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 Windows OS and Linux

Programming tools recommended: -

Information Security : - C/C++/Java

Augmented and Virtual Reality :- Unity, C#, Blender, VRTK, ARTK, Vuforia

VR Devices: HTC Vive, Google Daydream and Samsung gear VR.

Cloud Computing :-

Software Modeling and Architectures: Front end:HTML5, Bootstrap, jQuery, JS etc.

Backend: MySQL/MongoDB/NodeJS

### **Virtual Laboratory:**

Software Modeling and Architectures : <http://vlabs.iitkgp.ernet.in/se>

Information Security : <http://cse29-iiith.vlabs.ac.in>

### **Part I : Artificial Intelligence**

### **Suggested List of Laboratory Experiments/Assignments**

Sr. No.	<b>Group A</b> <b>All assignments are compulsory</b>
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 Algorithm for any game search problem.

	<p>3. Implement Greedy search algorithm for any of the following application:</p> <ul style="list-style-type: none"> <li>I. Selection Sort</li> <li>II. Minimum Spanning Tree</li> <li>III. Single-Source Shortest Path Problem</li> <li>IV. Job Scheduling Problem</li> <li>V. Prim's Minimal Spanning Tree Algorithm</li> <li>VI. Kruskal's Minimal Spanning Tree Algorithm</li> <li>VII. Dijkstra's Minimal Spanning Tree Algorithm</li> </ul>
	<b>Group B</b>
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.	Develop an elementary chatbot for any suitable customer interaction application.

	<b>Group C</b>
6.	Implement any one of the following Expert System <ul style="list-style-type: none"> <li>I. Information management</li> <li>II. Hospitals and medical facilities</li> <li>III. Help desks management</li> <li>IV. Employee performance evaluation</li> <li>V. Stock market trading</li> <li>VI. Airline scheduling and cargo schedules</li> </ul>
<b>Part II : Elective II</b>	
<b>Suggested List of Laboratory Experiments/Assignments</b>	
<b>Sr. No.</b>	<b>Assignment Name</b>
	<b>Information Security (Any five)</b>
1.	Write a Java/C/C++/Python program that contains a string (char pointer) with a value 'Hello World'. The program should AND or and XOR each character in this string with 127 and display the result.
2.	Write a Java/C/C++/Python program to perform encryption and decryption using the method of Transposition technique.
3.	Write a Java/C/C++/Python program to implement DES algorithm.
4.	Write a Java/C/C++/Python program to implement AES Algorithm.
5.	Write a Java/C/C++/Python program to implement RSA algorithm.
6.	Implement the Diffie-Hellman Key Exchange mechanism using HTML and JavaScript. Consider the end user as one of the parties (Alice) and the JavaScript application as other party (bob).
7.	Calculate the message digest of a text using the MD5 algorithm in JAVA.
	<b>Cloud Computing (All assignments are compulsory)</b>
1.	Case study on Microsoft azure to learn about Microsoft Azure is a cloud computing platform and infrastructure, created by Microsoft, for building, deploying and managing applications and services through a global network of Microsoft-managed data centers. <b>OR</b> Case study on Amazon EC2 and learn about Amazon EC2 web services.
2.	Installation and configure Google App Engine. <b>OR</b>

	Installation and Configuration of virtualization using KVM.
3.	Creating an Application in SalesForce.com using Apex programming Language.
4.	Design and develop custom Application (Mini Project) using Salesforce Cloud.
5.	<p style="text-align: center;"><b>Mini-Project</b></p> <p>Setup your own cloud for Software as a Service (SaaS) over the existing LAN in your laboratory. In this assignment you have to write your own code for cloud controller using open-source technologies to implement <b>with HDFS</b>. Implement the basic operations may be like to divide the file in segments/blocks and upload/ download file on/from cloud in encrypted form.</p>
	<p><b>Augmented and Virtual Reality</b></p> <p><b>(Assignments 1,2, 3,7 are mandatory, any 2 from 4, 5 &amp; 6)</b></p>
1.	Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
2.	Demonstration of the working of HTC Vive, Google Daydream or Samsung gear VR.
3.	<p>Develop a scene in Unity that includes:</p> <ul style="list-style-type: none"> <li>i. A cube, plane and sphere, apply transformations on the 3 game objects.</li> <li>ii. Add a video and audio source.</li> </ul>
4.	Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects. Change the color, material and texture of each Game object separately in the scene. Write a C# program in visual studio to change the color and material/textured of the game objects dynamically on button click.
5.	Develop and 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.	<p>Develop and deploy an AR app, implement the following using Vuforia Engine developer portal:</p> <ul style="list-style-type: none"> <li>i. Plane detection</li> <li>ii. Marker based Tracking(Create a database of objects to be tracked in Vuforia)</li> <li>iii. Object Tracking</li> </ul>
7.	<p style="text-align: center;"><b>Mini-Projects/ Case Study</b></p> <p>Create a multiplayer VR game (battlefield game). The game should keep track of score, no. of chances/lives, levels (created using different scenes), involve interaction, animation and immersive environment.</p> <p style="text-align: center;"><b>OR</b></p> <p>Create a treasure hunt AR application which should have the following features:</p> <ul style="list-style-type: none"> <li>i. A help button for instruction box to appear.</li> <li>ii. A series of markers which would give hints on being scanned.</li> <li>iii. Involve interaction, sound, and good UI.</li> </ul>
	<p><b>Software Modeling and Architectures</b></p> <p><b>(Problem statement 1, 2 , 3 or 4, Problem statement 5 and 6 are mandatory )</b></p>
1.	<p>Consider a library, where a member can perform two operations: issue book and return it. A book is issued to a member only after verifying his credentials. Develop a use case diagram for the given library system by identifying the actors and use cases and associate the use cases with the actors by drawing a use case diagram. Use UML tool.</p>
2.	<p>Consider online shopping system. Perform the following tasks and draw the class diagram using UML tool.</p> <p>Represent the individual classes, and objects</p> <p>Add methods</p> <p>Represent relationships and other classifiers like interfaces</p>
3.	Consider the online shopping system in the assignment 2.

	Draw the sequence diagram using UML tool to show message exchanges
4.	<p>Consider your neighboring travel agent from whom you can purchase flight tickets. To book a ticket you need to provide details about your journey i.e., on which date and at what time you would like to travel. You also need to provide your address. The agency has recently been modernized. So, you can pay either by cash or by card. You can also cancel a booked ticket later if you decide to change your plan. In that case you need to book a new ticket again. Your agent also allows you to book a hotel along with flight ticket. While cancelling a flight ticket you can also cancel hotel booking. Appropriate refund as per policy is made in case of cancellation.</p> <p>Perform the following tasks and draw the use case diagram using UML tool.</p> <ul style="list-style-type: none"> <li>a. Identify the use cases from a given non-trivial problem statement.</li> <li>b. Identify the primary and secondary actors for a system.</li> <li>c. Use to generalization of use cases and «include» stereotypes to prevent redundancy in the coding phase</li> </ul>

### Mini-Projects

5.	Select a moderately complex system and narrate concise requirement Specification for the same. Design the system indicating system elements organizations using applicable architectural styles and design patterns with the help of a detailed Class diagram depicting logical architecture. 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.
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### Learning Resources

#### Text Books:

##### **Artificial Intelligence**

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

##### **Information Security**

1. Atul Kahate, “Cryptography and Network Security”, 3e, McGraw Hill Education
2. Prakash C. Gupta, “Cryptography and Network Security”, PHI
3. V.K. Pachghare, “Cryptography and Information Security”, PHI Learning

##### **Cloud Computing**

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

##### **Augmented and Virtual Reality**

1. William R Sherman and Alan B Craig, “Understanding Virtual Reality: Interface, Application and Design”, (The Morgan Kaufmann Series in Computer Graphics)”. Morgan Kaufmann Publishers, San Francisco, CA, 2002
2. Alan B Craig, “Understanding Augmented Reality, Concepts and Applications”, Morgan Kaufmann Publishers, ISBN:978-0240824086

### **Software Modelling and Architectures**

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. Hassan Gomaa, "Software Modeling and Design- UML, Use cases, Patterns and Software Architectures", Cambridge University Press, 2011, ISBN 978-0-521-76414-8
4. Erich Gamma, "Design Patterns", Pearson, ISBN 0-201-63361-2

#### **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

#### **Information Security**

1. William Stallings, Lawrie Brown, "Computer Security Principles and Practice", 3rd\_Edition, Pearson
2. William Stallings, "Cryptography and Network Security Principals and Practice", Fifth edition, Pearson
3. Nina Godbole, Sunit Belapure, "Cyber Security", Wiley, ISBN: 978-81-265-2179-1

#### **Augmented and Virtual Reality**

1. Steven M. LaValle, "Virtual Reality", Cambridge University Press, 2016
2. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann, 2009.
3. Schmalstieg / Hollerer, "Augmented Reality: Principles & Practice", Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
4. Sanni Siltanen, "Theory and applications of marker-based augmented reality", Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0

#### **Cloud Computing**

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.

#### **Software Modelling and Architectures**

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.

#### **@The CO-PO Mapping Matrix**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	2	-	2	-	3	-	-	2	2	2	1	2

<b>CO2</b>	1	-	2	2	3	2	-	2	2	2	1	2
<b>CO3</b>	1	-	2	2	3	2	-	2	2	2	2	2
<b>CO4</b>	1	-	2	-	3	-	-	2	2	2	2	2
<b>CO5</b>	1	-	2	-	3	-	-	2	2	2	2	2
<b>CO6</b>	1	-	2	-	3	-	-	2	2	2	2	2

**Savitribai Phule Pune University**  
**Third Year of Engineering (2019 Course)**  
**310259: Audit Course 6**

 Home

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

**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 6 Options**

<b>Audit Course Code</b>	<b>Audit Course Title</b>
<b>AC6-I</b>	Digital and Social Media Marketing
<b>AC6-II</b>	Sustainable Energy Systems
<b>AC6-III</b>	Leadership and Personality Development
<b>AC6-IV</b>	Foreign Language (one of Japanese/Spanish/French/German). Course contents for <b>Japanese (Module 4)</b> are provided. For other languages institute may design suitably.
<b>AC6-V</b>	MOOC- Learn New Skills

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](http://www.unipune.ac.in/university_files/syllabi.htm)

## AC6-I Digital and Social Media Marketing

**Prerequisites:** Internet Technologies

**Course Objectives:**

- To understand the importance of digital marketing
- To understand the social media and marketing
- To understand the effective marketing strategies and ways

**Course Outcomes:**

On completion of the course, learners will be able to

**CO1:** Understand the fundamentals and importance of digital marketing

**CO2:** Use the power of social media for business marketing

**CO3:** Analyze the effectiveness of digital marketing and social media over traditional process

### Course Contents

1. A Framework for Digital Marketing
2. Domain Names, Email, and Hosting
3. Yes, You need a Website
4. The Three Components of a Modern Website: Mobile, Fast, and Accessible
5. Lock It Down: Digital Privacy, Data Security, and the Law
6. Social Media
7. Email Marketing
8. Online Advertising

**Reference Books :**

1. Avery Swartz, “See You on the Internet: building your small business with Digital Marketing”, ISBN 978-1-989603-08-6.
2. Social Media Marketing Workbook (2021): How to Use Social Media for Business (2021 Social Media Marketing 1).

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<b>CO2</b>	-	1	2	-	1	-	-	-	-	-	1	-
<b>CO3</b>	2	-	2	2	1	-	1	-	-	-	-	-

## AC6-II Sustainable Energy Systems

**Prerequisites:** 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 technologies
- To learn about adequate inputs on a variety of issues in harnessing renewable energy
- To recognize current and possible future role of renewable energy sources

**Course Outcomes:**

On completion of the course, learners will be able to

**CO1:** Comprehend the importance of Sustainable Energy Systems

**CO2:** Correlate the human population growth and its trend to the natural resource degradation and develop the awareness about his/her role towards Sustainable Energy Systems protection

**CO3:** Identify different types of natural resource pollution and control measures

**CO4:** Correlate the exploitation and utilization of conventional and non-conventional resources

### Course Contents

1. **Wind Energy:** Power in the Wind, Types of Wind Power Plants (WPPs), Components of WPPs, Working of WPPs, Siting of WPPs, Grid integration issues of WPPs.
2. **Solar Pv and Thermal Systems:** Solar Radiation, Radiation Measurement, Solar Thermal Power Plant, Central Receiver Power Plants, Solar Ponds, Thermal Energy storage system with PCM, Solar Photovoltaic systems: Basic Principle of SPV conversion, Types of PV Systems, Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array, PV Module I-V Characteristics, Efficiency and Quality of the Cell, series and parallel connections, maximum power point tracking, Applications.
3. **Other Energy Sources:** Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC), Hydrogen Production and Storage. Fuel cell: Principle of working, various types, construction and applications. Energy Storage System, Hybrid Energy Systems.

**Reference Books :**

1. Joshua Earnest, Tore Wizeliu, "Wind Power Plants and Project Development", PHI Learning Pvt.Ltd, New Delhi, 2011.
2. D.P.Kothari, K.C Singal, Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt.Ltd, New Delhi, 2013.
3. A.K.Mukerjee and Nivedita Thakur, "Photovoltaic Systems: Analysis and Design", PHI Learning Private Limited, New Delhi, 2011

### @The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO12
<b>CO1</b>	-	-	-	-	-	-	1	-	-	-	-	-
<b>CO2</b>	-	-	-	-	-	-	2	-	-	-	-	1
<b>CO3</b>	-	-	-	-	-	-	1	-	-	-	-	-
<b>CO4</b>	-	-	-	-	-	2	2	-	-	-	-	2

## AC6-III Leadership and Personality Development

**Prerequisites:** General awareness of communication and relationship.

**Course Objectives:**

- To understand the importance of communication
- To create awareness about teamwork and people skills
- To know thyself
- To recognize current and possible future of new-age thinking

**Course Outcomes:**

On completion of the course, learners will be able to

**CO1:** Express effectively through communication and improve listening skills

**CO3:** Develop effective team leadership abilities.

**CO4:** Explore self-motivation and practicing creative/new age thinking.

**CO5:** Operate effectively in heterogeneous teams through the knowledge of team work, people skills and leadership qualities.

### Course Contents

**1. Communication :**

Listening Skills, Communication - 7 C's, Vision and Charisma, Planning and Organizing - Complex Tasks and Ideas --> Actionable Tasks, Presentation Skills.

**2. Teamwork and People Skills :**

Talent Picking skills, Strong networking and Employee engagement, Coach and Mentor the team, Influencing, Delegate and Empower, Generous, open communicator, Patience and Clarity of Mind, Inspire and Motivate, Ensure Team Cohesion, Empathy, Trust and Reliability.

**3. New-age Thinking :**

Strategic Thinking, Critical and Lateral Thinking, Problem Solving Skills, Flexibility, Change Management – VUCA.

**4. Self-Awareness :**

What is Self? – Real, Ideal and Social Self, Concepts related to Self - Self Concept, Self-Presentation, Self-Regulation and Impression Management, Definition and Causes of Prejudice, Relationship between Prejudice, Discrimination and Exclusion, Application – Attitudinal Change and Reducing Prejudices, Self Esteem and Self Awareness, SWOT – JOHARI, Self Esteem Quiz, Introduce Your Partner, Self Introduction - How to sell yourself?- appearance, voice modulation, verbal(simple language), Motivation and Optimism, Positive Emotions and Success.

**Reference Books :**

1. Paul Sloane, “The Leader's Guide to Lateral Thinking Skills Unlocking the Creativity and Innovation in You and Your Team”, 2006
2. Ronald Bennett, Elaine Millam, “Leadership for engineers : the magic of mindset”
3. Urmila Rai and S.M. Rai, “Business Communication”, Himalay Publication House
4. Baron R, Byrne D, Branscombe N, BharadwajG ( 2009), “Social Psychology, Indian adaptation”, Pearson , New Delhi
5. Baumgartner S.R, Crothers M.K. (2009) “Positive Psychology”, Pearson Education.

### @The CO-PO Mapping Matrix

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	1	-	-	-	-	2	-	1	1	3	-	2

<b>CO2</b>	-	-	-	-	-	-	-	1	-	2	1	2
<b>CO3</b>	-	-	-	-	-	1	-	-	2	1	-	1
<b>CO4</b>	-	-	-	-	-	-	-	1	-	-	2	1

#### AC6-IV: Foreign Language ( Japanese ) Module 4

**Prerequisites:** We recommend that candidates should have previously completed AC3-V(210251) , AC4-V (210260) and AC-5(310250)

**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:** Have the ability to communicate confidently and clearly in the Japanese language

**CO2:** Understand the nature of Japanese script

**CO3:** Get introduced to reading, writing and listening skills

**CO4:** Develop interest to pursue further study, work and leisure

#### Course Contents

1. Introduction to types of adjectives (i and na)
2. Formation of adjectives (according to tense / negative / affirmative)
3. Introduction to more particles
4. Making sentences using various particles / verbs / adjectives
5. Topic based vocabulary (Places / Train travel related / Technical Katakana words)
6. More verb forms (te form, ta form, nai form, root verb etc.)
7. Question words
8. Further 25 Kanjis
9. Scenario based conversation practice / skits / role plays (At the market, At the hospital etc.)

**Reference Books :**

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](http://www.tcs.com/news_events/press_releases/Pages/TCS-Inaugurates-Japan-centric-Delivery-Center-Pune.aspx))
3. Kazuko Karasawa, Mikiko Shibuya, "Nihongo Challenge N4 N5 Kannji Tomoko Kigami", ISBN-10 4872177576, Ask Publishing Co.,Ltd.

#### @The CO-PO Mapping Matrix

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

#### AC6-V: MOOC- Learn New Skills

**Prerequisites:** Software Engineering (210253)

**Course Objectives:**

- To understand the fundamentals of DevOps
- To understand the Agility and ways of Agility
- To understand the software development using Agility approach

**Course Outcomes:**

On completion of the course, learner will be able to

**CO1:** Illustrate the agility and principles

**CO2:** Understand the software development using agile methodology

**CO3:** Apply DevOps for the software product development

**CO4:** Develop software products for early delivery through continual feedback and learning

**Course Contents**

- THE THREE WAYS :** Agile, continuous delivery and the three ways, The First Way: The Principles of Flow, The Second Way: The Principle of Feedback, The Third Way: The Principles of Continual Learning.
- WHERE TO START :** Selecting which value stream to start with, Understanding the work in our value stream..., How to design our organization and architecture, How to get great outcomes by integrating operations into the daily work for development.
- THE FIRST WAY: THE TECHNICAL PRACTICES OF FLOW :** Create the foundations of our deployment pipeline, Enable fast and reliable automated testing, Enable and practice continuous integration, Automate and enable low-risk releases, Architect for low-risk releases.
- THE SECOND WAY: THE TECHNICAL PRACTICES OF FEEDBACK :** Create telemetry to enable seeing and solving problems, Analyze telemetry to better anticipate problems, Enable feedback so development and operation can safely deploy code, Integrate hypothesis-driven development and A/B testing into our daily work, Create review and coordination processes to increase quality of our current work.
- THE THIRD WAY: THE TECHNICAL PRACTICES OF CONTINUAL LEARNING :** Enable and inject learning into daily work, Convert local discoveries into global improvements, Reserve time to create organizational learning, Information security as everyone's job, every day, Protecting the deployment pipeline.

**Reference Books :**

- Gene Kim, Jez Humble, Petrick Debois, "The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations"
- Len Bass, Ingo Weber, Liming Zhu, "DevOps: A Software Architect's Perspective" Publisher(s): Addison-Wesley Professional, ISBN: 9780134049885

**@The CO-PO Mapping Matrix**

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

## Acknowledgement

It is with great pleasure and honor that I share the curriculum for Third Year of Computer Engineering (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 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. Pramod D. Patil (Dr. D. Y. Patil Institute of Technology, Pimpri), 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. Santosh Kumar Chobe, Dr. Jyoti Rao, Dr. Swati Nikam, Dr. C. R. Jadhav, Dr. S. S. Das, Dr. Rachna Somkunwar, Prof. Rajesh D. Bharati, Prof. Rupesh Mahajan 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 Prof. Abhijit D. Jadhav, Dr. D. Y. Patil Institute of Technology, Pimpri for the time he has spent in critically reading the draft and giving the final touches. I appreciate his initiative and thank him for his 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, Board of Studies (BoS), Computer Engineering, Faculty of Science and Technology, Savitribai Phule Pune University.

BoS Members- Dr. Shirish Sane, Dr. Sunil Bhirud, Dr. Manik Dhore, Dr. Pramod Patil, Dr. Rajesh Prasad, 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.

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<b>Elective I: Distributed System</b>	Dr. Amar Buchade	Prof. Rajesh Bharati Dr. Suresh V. Limkar Mr. Pratik Dixit (Industry)	Dr. Swati A. Bhavsar Dr. Sonali Patil Dr. Rachna Somkunwar Mr. Vijay Bahiraji (Industry)
<b>Elective I: Software Project Management</b>	Dr. Sachin Sakhare	Dr. R. L. Paikrao Prof. Santosh Sambare Prof. Pimpalkar S.P.	Prof. Shinde Sushma S Prof. Mrs. Vina M Lomte Mr. Prashant Pund (Industry) Mr. Shekhar Dhupkar (Industry)
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<b>Computer Networks and Security Laboratory</b>	Dr. Vinod V. Kimbahune	Dr. P. B. Kumbharkar Dr. Aparna A. Junnarkar Dr. A.V. Dhumane	Prof. D. B. Gothwal Dr. M. L. Dhore
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<b>Seminar</b>	Dr. Swati A. Bhavsar		

<b>Audit Course 5</b>	Dr. Kishor Wagh	Dr. S. S. Das Dr. D. V. Patil	Dr. Sandeep Patil Dr. Bendre Mr. B. B. Gite
<b>Data Science and Big Data Analytics</b>	Dr. Sheetal Sonawane	Dr. H. K. Khanuja Prof. Devidas S. Thosar Dr. S. K. Shinde Mr. Anand Bhalerao (Industry) Mr. Amod Vaidya (Industry)	Dr. B. D. Phulpagar Dr. K. V. Metre Mr. Atul Bengeri (Industry) Mr. Summer Patil (Industry) Mr. Sanjeev Kumar (Industry)
<b>Web Technology</b>	Prof. Abhijit D. Jadhav	Prof. Jayvant Devare	Mr. Avinash Patil (Industry) Mr. Saikrishna Mamidishetty (Industry)
<b>Artificial Intelligence</b>	Dr. J. R. Prasad	Dr. Gayatri M. Bhandari Dr. V. P. Vikhe Dr. Snehal Mohan Kamalapur	Dr. K Rajeswari Dr. Mrs. Madhuri Pote
<b>Elective II: Information Security</b>	Dr. Swati Nikam	Dr Pathan Mohd Shafi Dr. Mininath Nighot Dr. Ms. K.C. Nalavade	Dr. Lomte Archana C. Dr. Amol Potgantwar Mr. Akshay Kokil (Industry)
<b>Elective II: Augmented and Virtual Reality</b>	Dr. Shaikh Nuzhat Faiz	Prof. Sagar Balasaheb Shinde Prof. Shweta Ashish Koparde	Prof. Sanjay Agrawal Prof. Priyanka More
<b>Elective II: Cloud Computing</b>	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)
<b>Elective II: Software Modeling and Architectures</b>	Dr M A Pradhan	Prof. Mrs. Dipalee Divakar Rane Prof. Jyoti Kulkarni	Dr. Neeta Deshpande Prof. Nareshkumar Mustary Dr. Aarti D K
<b>Internship</b>	Dr. Gitanjali V. Kale	Mr. Arun Kadekodi - (Industry) Mr. Nilesh Deshmukh - (Industry) Prof. Pradnya Kulkarni	Prof. Dheeraj Agrawal Prof. Pranjali Joshi
<b>Data Science and Big Data Analytics Laboratory</b>	Dr. H. K. Khanuja	Dr. Sheetal Sonawane Prof. Devidas S. Thosar Dr. S. K. Shinde Mr. Anand Bhalerao (Industry) Mr. Amod Vaidya (Industry)	Dr. B. D. Phulpagar Dr. K. V. Metre Mr. Atul Bengeri (Industry) Mr. Summer Patil (Industry) Mr. Sanjeev Kumar (Industry)
<b>Web Technology Laboratory</b>	Prof. Abhijit D. Jadhav	Mr. Avinash Patil (Industry)	Mr. Saikrishna Mamidishetty (Industry)
<b>Laboratory Practice II</b>	Dr. Snehal Mohan Kamalapur	Dr. K Rajeswari Dr. Pathan Mohd Shafi Dr. Shaikh Nuzhat Faiz	Dr. N. M. Ranjan Dr. M A Pradhan
<b>Audit Course 6</b>	Dr. Sangve Sunil M.	Dr. S. S. Das	Prof. Abhijit D. Jadhav

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**Faculty of Engineering  
Savitribai Phule Pune University, Pune  
Maharashtra, India**



**Curriculum  
for  
Fourth Year of Computer Engineering  
(2019 Course)  
(With effect from 2022-23)**

**Final Year of Computer Engineering  
(2019 Course)  
(With effect from 2022-23)**

## Prologue

It is with great pleasure and honor that I share the syllabi for Fourth Year of Computer Engineering (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 Year, Second Year and Third Year Computer Engineering Curriculum 2019:**

1. [http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/Rules%20and%20Regulations%20F.E.%202019%20Patt\\_10.012020.pdf](http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/Rules%20and%20Regulations%20F.E.%202019%20Patt_10.012020.pdf)
2. [http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/First%20Year%20Engineering%202019%20Patt.Syllabus\\_05.072019.pdf](http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/First%20Year%20Engineering%202019%20Patt.Syllabus_05.072019.pdf)
3. [http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2020/SE%20Computer%20Engg.%202019%20%20Patt\\_03.072020.pdf](http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2020/SE%20Computer%20Engg.%202019%20%20Patt_03.072020.pdf)
4. [http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2021/Third%20Year%20Engineering%202019%20Pattern\\_16022022.rar](http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2021/Third%20Year%20Engineering%202019%20Pattern_16022022.rar)

**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**(With effect from Academic Year 2022-23)**

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**Savitribai Phule Pune University**  
**Bachelor of Computer Engineering**  
**Program Outcomes (POs)**

**Learners are expected to know and be able to—**

<b>PO1</b>	<b>Engineering knowledge</b>	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems.
<b>PO2</b>	<b>Problem analysis</b>	Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences.
<b>PO3</b>	<b>Design / Development of Solutions</b>	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.
<b>PO4</b>	<b>Conduct Investigations of Complex Problems</b>	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.
<b>PO5</b>	<b>Modern Tool Usage</b>	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.
<b>PO6</b>	<b>The Engineer and Society</b>	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.
<b>PO7</b>	<b>Environment and Sustainability</b>	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
<b>PO8</b>	<b>Ethics</b>	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice.
<b>PO9</b>	<b>Individual and Team Work</b>	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
<b>PO10</b>	<b>Communication Skills</b>	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.
<b>PO11</b>	<b>Project Management and Finance</b>	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.
<b>PO12</b>	<b>Life-long Learning</b>	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)**

<b>PSO1</b>	<b>Professional Skills</b> -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.
<b>PSO2</b>	<b>Problem-Solving Skills</b> - 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.
<b>PSO3</b>	<b>Successful Career and Entrepreneurship</b> - 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.



## BE Computer Engineering 2019 Course tentative Curriculum structure:

<b>Savitribai Phule Pune University Fourth Year of Computer Engineering (2019 Course) (With effect from Academic Year 2022-23)</b>														
<b>Semester VII</b>														
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\Pre	Total	Lecture	Practical	Tutorial	
410241	<a href="#">Design and Analysis of Algorithms</a>	03	-	-	30	70	-	-	-	100	3	-	-	3
410242	<a href="#">Machine Learning</a>	03	-	-	30	70	-	-	-	100	3	-	-	3
410243	<a href="#">Blockchain Technology</a>	03	-	-	30	70	-	-	-	100	3	-	-	3
410244	<a href="#">Elective III</a>	03	-	-	30	70	-	-	-	100	3	-	-	3
410245	<a href="#">Elective IV</a>	03	-	-	30	70	-	-	-	100	3	-	-	3
410246	<a href="#">Laboratory Practice III</a>	-	04	-	-	-	50	50	-	100	-	2	-	2
410247	<a href="#">Laboratory Practice IV</a>	-	02	-	-	-	50	-	-	50	-	1	-	1
410248	<a href="#">Project Stage I</a>	-	02	-	-	-	50	-	-	50	-	2	-	2
<b>Total Credit</b>										<b>15</b>	<b>05</b>	-	<b>20</b>	
<b>Total</b>		<b>15</b>	<b>08</b>	-	<b>150</b>	<b>350</b>	<b>150</b>	<b>50</b>	-	<b>700</b>	<b>15</b>	<b>05</b>	-	<b>20</b>
410249	<a href="#">Audit Course 7</a>													<b>Grade</b>
<b>Elective III</b>						<b>Elective IV</b>								
<a href="#">410244(A) Pervasive Computing</a> <a href="#">410244(B) Multimedia Techniques</a> <a href="#">410244(C) Cyber Security and Digital Forensics</a> <a href="#">410244(D) Object Oriented Modeling and Design</a> <a href="#">410244(E) Digital Signal Processing</a>						<a href="#">410245(A) Information Retrieval</a> <a href="#">410245(B) GPU Programming and Architecture</a> <a href="#">410245(C) Mobile Computing</a> <a href="#">410245(D) Software Testing and Quality Assurance</a> <a href="#">410245(E) Compilers</a>								
<b>Laboratory Practice III:</b> Laboratory assignments Courses- 410241, 410242, 410243						<b>Laboratory Practice IV:</b> Laboratory assignments Courses- 410244, 410245								
<b>Audit Course 7(AC7) Options:</b> <a href="#">AC7- I MOOC- Learn New Skills</a> <a href="#">AC7- II Entrepreneurship Development</a> <a href="#">AC7- III Botnet of Things</a> <a href="#">AC7- IV 3D Printing</a> <a href="#">AC7- V Industrial Safety and Environment Consciousness</a>														



Savitribai Phule Pune University Final Year of Computer Engineering (2019 Course) (With effect from Academic Year 2022-23)														
Semester VIII														
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/Pre	Total	Lecture	Practical	Tutorial	Total
410250	<a href="#">High Performance Computing</a>	03	-	-	30	70	-	-	-	100	03			03
410251	<a href="#">Deep Learning</a>	03	-	-	30	70	-	-	-	100	03			03
410252	<a href="#">Elective V</a>	03	-	-	30	70	-	-	-	100	03			03
410253	<a href="#">Elective VI</a>	03	-	-	30	70	-	-	-	100	03			03
410254	<a href="#">Laboratory Practice V</a>	-	02	-	-	-	50	50	-	100		01		01
410255	<a href="#">Laboratory Practice VI</a>	-	02	-	-	-	50	-	-	50		01		01
410256	<a href="#">Project Stage II</a>	-	06	-	-	-	100	-	50	150		06		06
<b>Total Credit</b>										<b>12</b>	<b>08</b>	-	<b>20</b>	
<b>Total</b>		<b>12</b>	<b>10</b>	-	<b>120</b>	<b>280</b>	<b>200</b>	<b>50</b>	<b>50</b>	<b>700</b>	<b>12</b>	<b>08</b>	-	<b>20</b>
410257	<a href="#">Audit Course 8</a>										<b>Grade</b>			
<b>Elective V</b>					<b>Elective VI</b>									
<a href="#">410252(A) Natural Language Processing</a> <a href="#">410252(B) Image Processing</a> <a href="#">410252(C) Software Defined Networks</a> <a href="#">410252(D) Advanced Digital Signal Processing</a> <a href="#">410252(E) Open Elective I</a>					<a href="#">410253(A) Pattern Recognition</a> <a href="#">410253(B) Soft Computing</a> <a href="#">410253(C) Business Intelligence</a> <a href="#">410253(D) Quantum Computing</a> <a href="#">410253(E) Open Elective II</a>									
<b>Lab Practice V:</b> Laboratory assignments Courses- 410250, 410251					<b>Lab Practice VI:</b> Laboratory assignments Courses- 410252, 410253									
<b>Audit Course 8(AC8) Options:</b> <a href="#">AC8- I Usability Engineering</a> <a href="#">AC8- II Conversational Interfaces</a> <a href="#">AC8- III Social Media and Analytics</a> <a href="#">AC8- IV MOOC- Learn New Skills</a> <a href="#">AC8- V Emotional Intelligence</a>														

## 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

<b>TW: Term Work</b>	<b>TH: Theory</b>	<b>PR: Practical</b>
<b>OR: Oral</b>	<b>Sem: Semester</b>	

**Faculty of Engineering**

**Savitribai Phule Pune University**

# **SEMESTER VII**



## Savitribai Phule Pune University

### Fourth Year of Computer Engineering (2019 Course)

#### 410241: Design and Analysis of Algorithms

<b>Teaching Scheme:</b> TH: 03 Hours/Week	<b>Credit</b> <b>03</b>	<b>Examination Scheme:</b> <b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>
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**Prerequisites Courses:** Discrete Mathematics (210241), Fundamentals of Data Structures(210242, Data Structures and Algorithms(210252), Theory of Computation ( 310242)

**Companion Course:** Laboratory Practice III(410246)

#### **Course Objectives:**

- To develop problem solving abilities using mathematical theories.
- To apply algorithmic strategies while solving problems.
- To analyze performance of different algorithmic strategies in terms of time and space.
- To develop time and space efficient algorithms.
- To study algorithmic examples in distributed and concurrent environments
- To Understand Multithreaded and Distributed Algorithms

#### **Course Outcomes:**

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

**CO1:** Formulate the problem

**CO2:** Analyze the asymptotic performance of algorithms

**CO3:** Decide and apply algorithmic strategies to solve given problem

**CO4:** Find optimal solution by applying various methods

**CO5:** Analyze and Apply Scheduling and Sorting Algorithms.

**CO6:** Solve problems for multi-core or distributed or concurrent environments

#### **Course Contents**

<b>Unit I</b>	<b>Algorithms and Problem Solving</b>	<b>07 Hours</b>
Algorithm: The Role of Algorithms in Computing - What are algorithms, Algorithms as technology, Evolution of Algorithms, Design of Algorithm, Need of Correctness of Algorithm, Confirming correctness of Algorithm – sample examples, Iterative algorithm design issues. Problem solving Principles: Classification of problem, problem solving strategies, classification of timecomplexities (linear, logarithmic etc.)		
#Exemplar/Case Studies	Towers of Hanoi	
*Mapping of Course Outcomes for Unit I	CO1,CO3	
<b>Unit II</b>	<b>Analysis of Algorithms and Complexity Theory</b>	<b>07 Hours</b>
Analysis: Input size, best case, worst case, average case Counting Dominant operators, Growth rate, upper bounds, asymptotic growth, O, $\Omega$ , $\Theta$ , o and $\omega$ notations, polynomial and non-polynomial problems, deterministic and non-deterministic algorithms, P-class problems, NP-class of problems, Polynomial problem reduction NP complete problems- vertex cover and 3-SAT and NP hard problem - Hamiltonian cycle.		
#Exemplar/Case Studies	Analysis of iterative and recursive algorithm	

<b>*Mapping of Course Outcomes for Unit II</b>	CO2	
<b>Unit III</b>	<b>Greedy And Dynamic Programming algorithmic Strategies</b>	<b>08 Hours</b>
	Greedy strategy: Principle, control abstraction, time analysis of control abstraction, knapsack problem, scheduling algorithms-Job scheduling and activity selection problem. Dynamic Programming: Principle, control abstraction, time analysis of control abstraction, binomial coefficients, OBST, 0/1 knapsack, Chain Matrix multiplication.	
<b>#Exemplar/Case Studies</b>	Rail tracks connecting all the cities	
<b>*Mapping of Course Outcomes for Unit III</b>	CO3, CO4	
<b>Unit IV</b>	<b>Backtracking and Branch-n-Bound</b>	<b>08 Hours</b>
	Backtracking: Principle, control abstraction, time analysis of control abstraction, 8-queen problem, graph coloring problem, sum of subsets problem. Branch-n-Bound: Principle, control abstraction, time analysis of control abstraction, strategies-FIFO, LIFO and LC approaches, TSP, knapsack problem.	
<b>#Exemplar/Case Studies</b>	Airline Crew Scheduling	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO3, CO4	
<b>Unit V</b>	<b>Amortized Analysis</b>	<b>07 Hours</b>
	Amortized Analysis: Aggregate Analysis, Accounting Method, Potential Function method, Amortized analysis-binary counter, stack Time-Space tradeoff, Introduction to Tractable and Non-tractable Problems, Introduction to Randomized and Approximate algorithms, Embedded Algorithms: Embedded system scheduling (power optimized scheduling algorithm), sorting algorithm for embedded systems.	
<b>#Exemplar/Case Studies</b>	cutting stock problem	
<b>*Mapping of Course Outcomes for Unit V</b>	CO3, CO5	
<b>Unit VI</b>	<b>Multithreaded And Distributed Algorithms</b>	<b>07 Hours</b>
	Multithreaded Algorithms - Introduction, Performance measures, Analyzing multithreaded algorithms, Parallel loops, Race conditions. Problem Solving using Multithreaded Algorithms - Multithreaded matrix multiplication, Multithreaded merge sort. Distributed Algorithms - Introduction, Distributed breadth first search, Distributed Minimum Spanning Tree. String Matching- Introduction, The Naive string matching algorithm, The Rabin-Karp algorithm.	
<b>#Exemplar/Case Studies</b>	Plagiarism detection	



### Learning Resources

**Text Books:**

1. Parag Himanshu Dave, Himanshu Bhalchandra Dave, "Design And Analysis of Algorithms", Pearson Education, ISBN 81-7758-595-9
2. Gilles Brassard, Paul Bratley, "Fundamentals of Algorithmics", PHI, ISBN 978-81-203-1131-2

**Reference Books :**

1. Michael T. Goodrich, Roberto Tamassia, "Algorithm Design: Foundations," Analysis and Internet Examples, Wiley, ISBN 978-81-265-0986-7
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", MIT Press; ISBN 978-0-262-03384-8
3. Horowitz and Sahani, "Fundamentals of Computer Algorithms", University Press, ISBN: 978 817371 6126, 81 7371 6126
4. Rajeev Motwani and Prabhakar Raghavan, "Randomized Algorithms" Cambridge University Press, ISBN: 978-0-521-61390-3
5. Dan Gusfield, "Algorithms on Strings, Trees and Sequences", Cambridge University Press, ISBN: 0-521-67035-7

**e-Books :**

1. [https://www.tutorialspoint.com/design\\_and\\_analysis\\_of\\_algorithms/design\\_and\\_analysis\\_of\\_algorithms\\_tutorial.pdf](https://www.tutorialspoint.com/design_and_analysis_of_algorithms/design_and_analysis_of_algorithms_tutorial.pdf)
2. <https://www.ebooks.com/en-in/book/1679384/algorithms-design-techniques-and-analysis/m-h-alsuwailel>

**MOOC Courses links :**

- Design and Analysis of Algorithms - <https://nptel.ac.in/courses/106106131>

### @The CO-PO Mapping Matrix

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



## Savitribai Phule Pune University

### Fourth Year of Computer Engineering (2019 Course)

#### 410242: Machine Learning

<b>Teaching Scheme:</b> TH: 03 Hours/Week	<b>Credit</b> 03	<b>Examination Scheme:</b> <b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>
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**Prerequisite Courses:** Data Science and Big Data Analytics(310251)

**Companion Course:** Laboratory Practice III(410246)

#### **Course Objectives:**

- To understand the need for Machine learning
- To explore various data pre-processing methods.
- To study and understand classification methods
- To understand the need for multi-class classifiers.
- To learn the working of clustering algorithms
- To learn fundamental neural network algorithms.

#### **Course Outcomes:**

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

CO1: Identify the needs and challenges of machine learning for real time applications.

CO2: Apply various data pre-processing techniques to simplify and speed up machine learning algorithms.

CO3: Select and apply appropriately supervised machine learning algorithms for real time applications.

CO4: Implement variants of multi-class classifier and measure its performance.

CO5 :Compare and contrast different clustering algorithms.

CO6: Design a neural network for solving engineering problems.

#### **Course Contents**

<b>Unit I</b>	<b>Introduction To Machine Learning</b>	<b>07 Hours</b>
Introduction to Machine Learning, Comparison of Machine learning with traditional programming, ML vs AI vs Data Science.		
Types of learning: Supervised, Unsupervised, and semi-supervised, reinforcement learning techniques, Models of Machine learning: Geometric model, Probabilistic Models, Logical Models, Grouping and grading models, Parametric and non-parametric models.		
Important Elements of Machine Learning- Data formats, Learnability, Statistical learning approaches		
<b>#Exemplar/Case Studies</b>	Suppose you are working for Uber where a task to increase sales is given.Understand the requirements of the client	
<b>*Mapping of Course Outcomes for Unit</b>	CO1	
<b>Unit II</b>	<b>Feature Engineering</b>	<b>07 Hours</b>

Concept of Feature, Preprocessing of data: Normalization and Scaling, Standardization, Managing missing values, Introduction to Dimensionality Reduction, Principal Component Analysis (PCA), Feature Extraction: Kernel PCA, Local Binary Pattern.  
 Introduction to various Feature Selection Techniques, Sequential Forward Selection, Sequential Backward Selection.  
 Statistical feature engineering: count-based, Length, Mean, Median, Mode etc. based feature vector creation.  
 Multidimensional Scaling, Matrix Factorization Techniques.

**#Exemplar/CaseStudies**

You are a Data Scientist, and a client comes to you with their data. Client is running a few campaigns from the past few months, but no campaign seems effective. Client provides you the data of customers, product sales and past campaign success. They want to increase their sales and figure out which marketing strategy is working the best for them?  
 Questions for data scientists:  
 1. What data analysis approach will you follow?  
 2. What statistical approach do you need to follow?  
 How will you select important features?

**\*Mapping of Course**

CO2

**Outcomes for Unit II****Unit III****Supervised Learning : Regression****06 Hours**

Bias, Variance, Generalization, Underfitting, Overfitting, Linear regression, Regression: Lasso regression, Ridge regression, Gradient descent algorithm.

Evaluation Metrics: MAE, RMSE, R2

**#Exemplar/Case Studies**

Stock market price prediction

**\*Mapping of Course****Outcomes for Unit III**

CO3

**Unit IV****Supervised Learning : Classification****08 Hours**

Classification: K-nearest neighbour, Support vector machine.

Ensemble Learning: Bagging, Boosting, Random Forest, Adaboost.

Binary-vs-Multiclass Classification, Balanced and Imbalanced Multiclass Classification

Problems, Variants of Multiclass Classification: One-vs-One and One-vs-All

Evaluation Metrics and Score: Accuracy, Precision, Recall, F-score, Cross-validation, Micro-Average Precision and Recall, Micro-Average F-score, Macro-Average Precision and Recall, Macro-Average F-score.

**#Exemplar/Case Studies**

Prediction of Thyroid disorders such as Hyperthyroid, Hypothyroid, Euthyroid-sick, and Euthyroid using multiclass classifier.

**\*Mapping of Course****Outcomes for Unit IV**

CO4

**Unit V****Unsupervised Learning****07 Hours**

K-Means, K-medoids, Hierarchical, and Density-based Clustering, Spectral Clustering. Outlier analysis: introduction of isolation factor, local outlier factor.

Evaluation metrics and score: elbow method, extrinsic and intrinsic methods

<b>#Exemplar/Case Studies</b>	Market basket analysis/Customer Segmentation	
<b>*Mapping of Course Outcomes for Unit V</b>	CO5	
<b>Unit VI</b>	<b>Introduction To Neural Networks</b>	<b>07 Hours</b>
Artificial Neural Networks: Single Layer Neural Network, Multilayer Perceptron, Back Propagation Learning, Functional Link Artificial Neural Network, and Radial Basis Function Network, Activation functions, Introduction to Recurrent Neural Networks and Convolutional Neural Networks		
<b>#Exemplar/Case Studies</b>	Movie Recommendation System	
<b>*Mapping of Course Outcomes for Unit VI</b>	CO6	
<b>Learning Resources</b>		
<b>Text Books:</b>		
<ol style="list-style-type: none"> <li>1. Bishop, Christopher M., and Nasser M. Nasrabadi, "Pattern recognition and machine learning", Vol. 4.No. 4. New York: springer, 2006.</li> <li>2. Ethem Alpaydin, "Introduction to Machine Learning", PHI 2nd Edition-2013</li> </ol>		
<b>Reference Books:</b>		
<ol style="list-style-type: none"> <li>1. Tom Mitchell, " Machine learning", McGraw-Hill series in Computer Science, 1997</li> <li>2. Shalev-Shwartz, Shai, and Shai Ben-David, "Understanding machine learning: From theory to algorithms", Cambridge university press, 2014.</li> <li>3. Jiawei Han, Micheline Kamber, and Jian Pie, "Data Mining: Concepts and Techniques", Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807</li> <li>4. Hastie, Trevor, et al., "The elements of statistical learning: data mining, inference, and prediction", Vol. 2. New York: springer, 2009.</li> <li>5. McKinney, "Python for Data Analysis ",O' Reilly media, ISBN : 978-1-449-31979-3</li> <li>6. Trent hauk, "Scikit-learn", Cookbook , Packt Publishing, ISBN: 9781787286382</li> <li>7. Goodfellow I.,Bengio Y. and Courville, " A Deep Learning", MIT Press, 2016</li> </ol>		
<b>e-Books :</b>		
<ol style="list-style-type: none"> <li>1. Python Machine Learning : <a href="http://www.ru.ac.bd/wp-content/uploads/sites/25/2019/03/207_05_01_Rajchka_Using-Python-for-machine-learning-2015.pdf">http://www.ru.ac.bd/wp-content/uploads/sites/25/2019/03/207_05_01_Rajchka_Using-Python-for-machine-learning-2015.pdf</a></li> <li>2. Foundation of Machine Learning: <a href="https://cs.nyu.edu/~mohri/mlbook/">https://cs.nyu.edu/~mohri/mlbook/</a></li> <li>3. Dive into Deep Learning: <a href="http://d2l.ai/">http://d2l.ai/</a></li> <li>4. A brief introduction to machine learning for Engineers: <a href="https://arxiv.org/pdf/1709.02840.pdf">https://arxiv.org/pdf/1709.02840.pdf</a></li> <li>5. Feature selection: <a href="https://dl.acm.org/doi/pdf/10.5555/944919.944968">https://dl.acm.org/doi/pdf/10.5555/944919.944968</a></li> <li>6. Introductory Machine Learning Nodes : <a href="http://lcs.mit.edu/courses/ml/1718/MLNotes.pdf">http://lcs.mit.edu/courses/ml/1718/MLNotes.pdf</a></li> </ol>		
<b>MOOC Courses Links:</b>		
<ul style="list-style-type: none"> <li>• Introduction to Machine Learning : <a href="https://nptel.ac.in/courses/106105152">https://nptel.ac.in/courses/106105152</a></li> <li>• Introduction to Machine Learning (IIT Madras): <a href="https://onlinecourses.nptel.ac.in/noc22_cs29/prevew">https://onlinecourses.nptel.ac.in/noc22_cs29/prevew</a></li> <li>• Deep learning: <a href="https://nptel.ac.in/courses/106106184">https://nptel.ac.in/courses/106106184</a></li> </ul>		

@The CO-PO Mapping Matrix

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**410243: Blockchain Technology**

**Teaching Scheme:**  
**TH: 03 Hours/Week**

**Credit**  
**03**

**Examination Scheme:**  
**In-Sem (Paper): 30 Marks**  
**End-Sem (Paper): 70 Marks**

**Prerequisite Courses:** Computer Networks and Security(310244)

**Companion Course:** Laboratory Practice III(410246)

**Course Objectives:**

- Technology behind Blockchain
- Crypto currency, Bitcoin and Smart contracts
- Different consensus algorithms used in Blockchain
- Real-world applications of Blockchain
- To analyze Blockchain Ethereum Platform using Solidity
- To Describe Blockchain Case Studies

**Course Outcomes:**

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

- CO1: Interpret the fundamentals and basic concepts in Blockchain
- CO2: Compare the working of different blockchain platforms
- CO3: Use Crypto wallet for cryptocurrency based transactions
- CO4: Analyze the importance of blockchain in finding the solution to the real-world problems.
- CO5: Illustrate the Ethereum public block chain platform
- CO6: Identify relative application where block chain technology can be effectively used and implemented.

**Course Contents**

<b>Unit I</b>	<b>Mathematical Foundation for Blockchain</b>	<b>06 Hours</b>
Cryptography: Symmetric Key Cryptography and Asymmetric Key Cryptography, Elliptic Curve Cryptography (ECC), Cryptographic Hash Functions: SHA256, Digital Signature Algorithm (DSA), Merkel Trees.		
<u><b>#Exemplar/Case Studies</b></u>	Compare the Symmetric and Asymmetric Cryptography algorithms	
<u><b>*Mapping of Course Outcomes for Unit I</b></u>	CO1	
<b>Unit II</b>	<b>Feature Engineering</b>	<b>07 Hours</b>
History, Centralized Vs. Decentralized Systems, Layers of Blockchain: Application Layer, Execution Layer, Semantic Layer, Propagation Layer, Consensus Layer, Why is Block chain important? Limitations of Centralized Systems, Blockchain Adoption So Far.		
<u><b>#Exemplar/CaseStudies</b></u>	Study of a research paper based on Blockchain.	

<b>*Mapping of Course Outcomes for Unit II</b>	CO1	
<b>Unit III</b>	<b>Blockchain Platforms and Consensus in Blockchain</b>	<b>06 Hours</b>
Types of Blockchain Platforms: Public, Private and Consortium, Bitcoin, Ethereum, Hyperledger, IoTA, Corda, R3. Consensus in Blockchain: Consensus Approach, Consensus Elements, Consensus Algorithms, Proof of Work, Byzantine General problem, Proof of Stake, Proof of Elapsed Time, Proof of Activity, Proof of Burn.		
<b>#Exemplar/Case Studies</b>	Compare different consensus algorithms used in Blockchain Technology.	
<b>*Mapping of Course Outcomes for Unit III</b>	CO2	
<b>Unit IV</b>	<b>Cryptocurrency – Bitcoin, and Token</b>	<b>06 Hours</b>
Introduction, Bitcoin and the Cryptocurrency, Cryptocurrency Basics Types of Cryptocurrency, Cryptocurrency Usage, Cryptowallets: Metamask, Coinbase, Binance		
<b>#Exemplar/Case Studies</b>	Create your own wallet for crypto currency using any of the Blockchain Platforms.	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO3	
<b>Unit V</b>	<b>Blockchain Ethereum Platform using Solidity</b>	<b>06 Hours</b>
What is Ethereum, Types of Ethereum Networks, EVM (Ethereum Virtual Machine), Introduction to smart contracts, Purpose and types of Smart Contracts, Implementing and deploying smart contracts using Solidity, Swarm (Decentralized Storage Platform), Whisper (Decentralized Messaging Platform)		
<b>#Exemplar/Case Studies</b>	Study Truffle Development Environment.	
<b>*Mapping of Course Outcomes for Unit V</b>	CO4	
<b>Unit VI</b>	<b>Blockchain Case Studies</b>	<b>06 Hours</b>
Prominent Blockchain Applications, Retail, Banking and Financial Services, Government Sector, Healthcare, IOT, Energy and Utilities, Blockchain Integration with other Domains		
<b>#Exemplar/Case Studies</b>	Study 2 uses cases of Blockchain and write a detailed report on every aspect implemented in the same	
<b>*Mapping of Course Outcomes for Unit VI</b>	CO5, CO6	
<b>Learning Resources</b>		

**Text Books:**

1. Martin Quest, "Blockchain Dynamics: A Quick Beginner's Guide on Understanding the Foundations of Bit coin and Other Crypto currencies", Create Space Independent PublishingPlatform, 15-May-2018
2. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained", Second Edition, Packt Publishing, 2018
3. Alex Leverington, "Ethereum Programming", Packt Publishing, 2017

**Reference Books:**

1. Bikramaditya Singhal, Gautam Dhameja, Priyansu Sekhar Panda, "Beginning Blockchain ABeginner's Guide to Building Blockchain Solutions",2018
2. Chris Dannen, "Introducing Ethereum and Solidity", Foundations of Crypto currency andBlockchain Programming for Beginners
3. Daniel Drescher, "Blockchain Basics", A Non -Technical Introduction in 25Steps.
4. Ritesh Modi, "Solidity Programming Essentials", Packt Publishing,2018
5. Chandramouli Subramanian, Asha A George, Abhilash K A and Meena Karthikeyan, "Blockchain Technology", Universities Press, ISBN-9789389211634

**e-Books :**

1. [https://users.cs.fiu.edu/~prabakar/cen5079/Common/textbooks/Mastering\\_Blockchain\\_2nd\\_Edition.pdf](https://users.cs.fiu.edu/~prabakar/cen5079/Common/textbooks/Mastering_Blockchain_2nd_Edition.pdf)
2. [https://www.lopp.net/pdf/princeton\\_bitcoin\\_book.pdf](https://www.lopp.net/pdf/princeton_bitcoin_book.pdf)
3. <https://www.blockchainexpert.uk/book/blockchain-book.pdf>

**MOOC Courses Links:**

1. NPTEL Course on "Introduction to Blockchain Technology & Applications"  
<https://nptel.ac.in/courses/106/104/106104220/>
2. NPTEL Course on b  
<https://nptel.ac.in/courses/106/105/106105184/>

**@The CO-PO Mapping Matrix**

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective III**  
**410244(A): Pervasive Computing**

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	<b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>

**Prerequisite Courses:**-Internet of Thigs and Embedded Systems(310245A)

**Companion Course:** Laboratory Practice IV(410247)

**Course Objectives:**

- To introduce the characteristics, basic concepts and systems issues in pervasive computing.
- To illustrate smart devices and architectures in pervasive computing.
- To introduce intelligent systems and interactions in Pervasive computing.
- To identify the trends and latest development of the technologies in the area.
- To Understand Interaction Design – HCI and Wearable Computing Environment.
- To identify Security Challenges & Ethics in Pervasive Computing

**Course Outcomes:**

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

- CO1.Demonstrate fundamental concepts in pervasive computing.
- CO2.Explain pervasive devices and decide appropriate one as per the need of real timeapplications.
- CO3.Classify and analyze context aware systems for their efficiency in different ICT systems.
- CO4.Illustrate intelligent systems and generic intelligent interactive applications.
- CO5.Design HCI systems in pervasive computing environment.
- CO6.Explore the security challenges and know the role of ethics in the context of pervasivecomputing.

**Course Contents**

Unit I	Introduction To Pervasive Computing	07 Hours
Pervasive Computing: History, Principles, Characteristics, Problems/Issues & Challenges, Advantages of Pervasive Computing		
Pervasive Computing Applications:	Pervasive computing devices and interfaces, Device technology trends, Connecting issues and protocols.	
#Exemplar/Case Studies	Pervasive Computing for Personalized medicine	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Smart Computing with Pervasive Computing Devices	07 Hours
Smart Devices: CCI, Smart Environment: CPI and CCI, Smart Devices: iHCI and HPI, Wearable devices, Application and Requirements, Device Technology and Connectivity, PDA Device characteristics - PDA Based Access Architecture, Voice Enabling Pervasive Computing: Voice Standards, Speech Applications in Pervasive Computing.		

<u>#Exemplar/CaseStudies</u>	Amazon Alexa	
<u>*Mapping of Course Outcomes for Unit II</u>	CO2	
<b>Unit III</b>	<b>Context Aware Systems</b>	<b>07 Hours</b>
Introduction, Types of Context, Context Aware Computing and Applications, Modelling Context-Aware Systems, Mobility awareness, spatial awareness, temporal awareness: Coordinating and scheduling, ICT system awareness, Middleware Support		
<b>#Exemplar/Case Studies</b>		
<u>#Exemplar/Case Studies</u>	Mobile Hanging Services systems	
<u>*Mapping of Course Outcomes for Unit III</u>	CO3	
<b>Unit IV</b>	<b>Intelligent Systems and Interaction</b>	<b>07 Hours</b>
Introduction, Basic Concepts, IS Architectures, Semantic KBIS, Classical Logic IS, Soft Computing IS Models, IS System Operations, Interaction Multiplicity, IS Interaction Design, Generic Intelligent Interaction Applications.		
<u>#Exemplar/Case Studies</u>	Curious information displays: A motivated reinforcement learning IE application.	
<u>*Mapping of Course Outcomes for Unit IV</u>	CO4	
<b>Unit V</b>	<b>User Interaction Design – HCI and Wearable Computing</b>	<b>07 Hours</b>
Introduction of Interaction Design, Basics of Interaction Design and its Concepts, Importance of Interaction Design, Difference between Interaction Design and UX. What is HCI? Importance of HCI, Advantages and Disadvantages of HCI, Elements of HCI, HCI Design and Architecture, Define Wearable Computing, Importance of Wearable Computing, Security issues in Wearable Computing, Wearable Computing Architecture and Applications, Wearable Computing Challenges and Opportunities for Privacy Protection		
<u>#Exemplar/Case Studies</u>	Smart Fabric/ Textile, Sensory Fabric for Ubiquitous interfaces	
<u>*Mapping of Course Outcomes for Unit V</u>	CO5	
<b>Unit VI</b>	<b>Security Challenges &amp; Ethics in Pervasive Computing</b>	<b>07 Hours</b>
Security issues in Pervasive Computing: security model, authentication & authorization, access control, secure resource discovery, open issues. Pervasive computing security challenges & requirements: Privacy & trust issues, social & user interaction issues, solution for pervasive computing challenges, Role of Ethics in pervasive computing security: Autonomy and Self-determination, Responsibility: legal, moral & social, distributive justice, digital divide and sustainable development		
<u>#Exemplar/Case Studies</u>	Pervasive Computing Security Gaia Project	
<u>*Mapping of Course Outcomes for Unit VI</u>	CO6	
<b>Learning Resources</b>		

**Text Books:**

1. Stefan Poslad, "Ubiquitous Computing: Smart Devices: Environments and Interactions", Wiley Publication, Student Edition, ISBN 9788126527335.
2. Jochen Burkhardt, Horst Henn, Stefan Hepper, Klaus Rindtrotf, Thomas Schack, "Pervasive Computing: Technology and Architecture of Mobile Internet Applications", Pearson Education, ISBN 9788177582802
3. Frank Adelstein, Sandeep K. S. Gupta, Golden G. Richard III, Loren Schwiebert, "Fundamentals of Mobile and Pervasive Computing" McGraw Hill Education, Indian Edition, ISBN 9780070603646

**Reference Books:**

1. Sen Loke, "Context Aware Pervasive Systems; Architectures for new Breed of applications", Taylor and Francis, ISBN 0-8493-7255-0
2. Laurnce Yang, Evi Syukur, Seng Loke, "Handbook on Mobile and Ubiquitous Computing : Status and Perspective]", CRC Press, 2013 ISBN 978-1-4398-4811-1
3. M. Haque and S. I. Ahamed, "Security in pervasive computing: Current status and open issues", Int. J. Netw. Secur., vol. 3, no. 3, pp. 203–214, 2006.

**e-Books :**

1. M. Hilty, -Ubiquitous Computing in the Workplace: What Ethical Issues?|| no. August, pp. 1–16, 2014, [Online]. <http://link.springer.com/bookseries/11156>L.
2. <https://web.uettaxila.edu.pk/CMS/SP2014/teMPCms/tutorial%5CFundamentalsOfMobilePervasiveComputing.pdf>
3. [http://pervasivecomputing.se/M7012E\\_2014/material/Wiley.Ubiquitous.Computing.Smart.Devices.Environments.And.Interactions.May.2009.eBook.pdf](http://pervasivecomputing.se/M7012E_2014/material/Wiley.Ubiquitous.Computing.Smart.Devices.Environments.And.Interactions.May.2009.eBook.pdf)
4. [http://media.techtarget.com/searchMobileComputing/downloads/mobile\\_and\\_pervasive\\_computing\\_Ch06.pdf](http://media.techtarget.com/searchMobileComputing/downloads/mobile_and_pervasive_computing_Ch06.pdf)

**MOOC Courses Links:**

<https://www.georgiancollege.ca/academics/part-time-studies/courses/mobile-and-pervasive-computing-comp-3025/>

[@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	2	2	--	--	--	--	--	--	--	--
CO3	3	3	3	3	--	--	--	--	--	--	--	--
CO4	3	2	3	3	--	--	--	--	--	--	--	--
CO5	3	3	3	3	--	--	--	--	--	--	--	--
CO6	1	2	-	3	--	--	--	--	--	--	--	--



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective III**  
**410244(B): Multimedia Techniques**

<b>Teaching Scheme:</b>  TH: 03 Hours/Week	<b>Credit</b>  03	<b>Examination Scheme:</b> In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
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**Prerequisite Courses:** Computer Graphics (210241)

**Companion Course:** Laboratory Practice IV(410247)

**Course Objectives:**

- To understand input and output devices, device drivers, control signals and protocols, DSPs
- To study and use standards (e.g., audio, graphics, video)
- To implement applications, media editors, authoring systems, and authoring by studying streams/structures, capture/represent/transform, spaces/domains, compression/coding
- To design and develop content-based analysis, indexing, and retrieval of audio, images, animation, and video
- To demonstrate presentation, rendering, synchronization, multi-modal integration/interfaces
- To Understand IoT architecture's and Multimedia Internet of things

**Course Outcomes:**

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

CO1: Describe the media and supporting devices commonly associated with multimedia information and systems.

CO2: Demonstrate the use of content-based information analysis in a multimedia information system.

CO3: Critique multimedia presentations in terms of their appropriate use of audio, video, graphics, color, and other information presentation concepts.

CO4: Implement a multimedia application using an authoring system.

CO5: Understanding of technologies for tracking, navigation and gestural control.

CO6: Implement Multimedia Internet of Things Architectures.

**Course Contents**

<b>Unit I</b>	<b>Introduction to multimedia</b>	<b>07 Hours</b>
What is Multimedia and their Components, History of Multimedia; Hypermedia, WWW, and Internet; Multimedia Tools: Static (text, graphics, and still images), Active (sound, animation, and video, etc.); Multimedia Sharing and Distribution; Multimedia Authoring Tools: Adobe Premiere, Adobe Director, Adobe Flash.		
<b>#Exemplar/Case Studies</b>	To study and install open-source multimedia Tools	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1	
<b>Unit II</b>	<b>Graphics and Data Representation Techniques</b>	<b>07 Hours</b>

What are Graphics data types, 1-bit Images, 8 –bit grey level ,16-bit grey level images, Image data type, Image data type: 8 bit & 24-bit color images, Higher bit depth images, Color Lookup tables. File Formats: GIF, JPEG, PNG, TIFF, PSD, APS, AI, INDD, RAW, Windows BMP, Windows WMF, Netpbm format, EXIF, PTM, Text file format: RTF, TGA Applications/Use of text in Multimedia

<b>#Exemplar/CaseStudies</b>	To study conversion of image file formats from one to Other.
<b>*Mapping of Course Outcomes for Unit II</b>	CO2

<b>Unit III</b>	<b>Multimedia Representations Techniques</b>	<b>07 Hours</b>
Principal concepts for the analog video: CRT, NTSC Video (National Television System Committee), PAL Video (Phase Alternating Line), SECAM Video (System Electronique Couleur Avec Memoire), Digital Video: Chroma Subsampling, High-Definition TV, Ultra High Definition TV (UHDTV), Component Video: High-Definition Multimedia Interface (HDMI), 3D Video and TV: various cues, Basics of Digital Audio: What is Sound?, Nyquist Theorem, SNR, SQNR, Audio Filtering, Synthetic Sounds, MIDI Overview: Hardware, Structure, Conversion to WAV, Coding of Audio: PCM, DPCM, DM (Delta Modulation)		

<b>#Exemplar/Case Studies</b>	Install and use Handbrake (link is <a href="https://handbrake.fr">https://handbrake.fr</a> ) software to understand the concept of interlaced, deinterlace, noise filters, bitrate, and frame rate for any sample 30 min video, and note down the observations from the output video.
<b>*Mapping of Course Outcomes for Unit III</b>	CO3

<b>Unit IV</b>	<b>Compression Algorithms</b>	<b>07 Hours</b>
Introduction to multimedia – Graphics, Image and Video representations – Fundamental concepts of video, digital audio – Storage requirements of multimedia applications – Need for compression – Types of compression algorithms- lossless compression algorithms RLC, VLC, DBC, AC, lossless image compression, differential coding of Images, lossy compression algorithms-Rate distortion theory, Quantization ,Transform coding, wavelet based coding, embedded Zerotress of wavelet coefficients . Image compression standard -JPEG standard, JPEG 2000 standard, LS standard, Bilevel image compression standard. Introduction to video compression - video compression based on motion compensation, Search for motion vectors, MPEG Video coding I , MPEG 1,2,4,7 onwards. Basic Audio Compression Techniques -ADPCM in speech coding, Vocoders, MPEG audio compression		

<b>#Exemplar/Case Studies</b>	Implementation of compression algorithms
<b>*Mapping of Course Outcomes for Unit IV</b>	CO3, CO4

<b>Unit V Augmented Reality(AR), Virtual Reality (VR) and Mixed Reality (MR)</b>	<b>07 Hours</b>
Basics of Virtual Reality, difference between Virtual Reality and Augmented Reality, Requirement of Augmented Reality, Components and Performance issues in AR, Design and Technological foundations for Immersive Experiences. Input devices – controllers, motion trackers and motion capture technologies for tracking, navigation and gestural control. Output devices – Head Mounted VR Displays, Augmented and Mixed reality glasses. 3D interactive and procedural graphics. Immersive surround sound. Haptic and vibrotactile devices. Best practices in VR, AR and MR Future applications of Immersive Technologies. VRML Programming Modeling objects and virtual environments Domain Dependent applications:	

Medical, Visualization, Entertainment, etc.

<b>#Exemplar/Case Studies</b>	Navigation Assistance System
<b>*Mapping of Course Outcomes for Unit V</b>	CO5

Unit VI	Multimedia Internet of Things	07 Hours
IoT and Multimedia IoT Architecture: IoT Architecture; M-IoT Architectures: Multi-Agent Based, AI-Based Software-Defined, Big Data Layered; Applications of M-IoT: Road Management System, Multimedia IoT in Industrial Applications, Health Monitoring		
<b>#Exemplar/Case Studies</b>	Traffic Monitoring System	
<b>*Mapping of Course Outcomes for Unit VI</b>	CO6	

### Learning Resources

#### Text Books:

1. Tay Vaughan, “Multimedia making it work”, Tata McGraw-Hill, 2011, ISBN: 978-0-07-174850-6 MHID: 0-07-174850-4, eBook print version of this title: ISBN: 978-0-07-174846-9, MHID: 0-07-174846-6
2. Ze-Nian Li, Mark S. Drew and Jiang chuan Liu, “Fundamentals of Multimedia”, Second Edition, Springer, 2011, ISSN 1868-0941 ISSN 1868-095X (electronic), ISBN 978-3-319-05289-2 ISBN 978-3-319-05290-8 (eBook), DOI 10.1007/978-3-319-05290-8, Pearson Education, 2009.

#### Reference Books:

1. Ali Nauman et al. “Multimedia Internet of Things: A Comprehensive Survey”, Special Section on Mobile Multimedia: Methodology and Applications, IEEE Access, Volume 8, 2020
2. Kelly S. Hale (Editor), Kay M. Stanney (Editor). 2014. Handbook of Virtual Environments: Design, Implementation, and Applications, Second Edition (Human Factors and Ergonomics) ISBN-13: 978-1466511842. Amazon

#### e-Books :

1. [https://users.dimi.uniud.it/~antonio.dangelo/MMS/materials/Fundamentals\\_of\\_Multimedia.pdf](https://users.dimi.uniud.it/~antonio.dangelo/MMS/materials/Fundamentals_of_Multimedia.pdf)
2. <https://mu.ac.in/wp-content/uploads/2021/04/Multimedia.pdf>
3. [https://www.baschools.org/pages/uploaded\\_files/chap13.pdf](https://www.baschools.org/pages/uploaded_files/chap13.pdf)

#### MOOC Courses Links:

- <https://nptel.ac.in/courses/117105083>

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective III**  
**410244(C): Cyber Security and Digital Forensics**

<b>Teaching Scheme:</b> <b>TH: 03 Hours/Week</b>	<b>Credit</b> <b>03</b>	<b>Examination Scheme:</b> <b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>
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**Prerequisite Courses:** Computer Networks and Security(310244), Information Security(310254(A))

**Companion Course:** 410246: Laboratory Practice IV

**Course Objectives:**

- To enhance awareness cyber forensics.
- To understand issues in cyber crime and different attacks
- To understand underlying principles and many of the techniques associated with the digital forensic practices
- To know the process and methods of evidence collection
- To analyze and validate forensic data collected.
- To apply digital forensic knowledge to use computer forensic tools and investigation report writing.

**Course Outcomes:** At the end of the course, the student should be able to:

CO1: Analyze threats in order to protect or defend it in cyberspace from cyber-attacks.

CO2: Build appropriate security solutions against cyber-attacks.

CO3:Underline the need of digital forensic and role of digital evidences.

CO4: Explain rules and types of evidence collection

CO5: Analyze, validate and process crime scenes

CO6: Identify the methods to generate legal evidence and supporting investigation reports.

**Course Contents**

<b>Unit 1</b>	<b>Introduction to Cyber Security</b>	<b>06 Hours</b>
Introduction and Overview of Cyber Crime, Nature and Scope of Cyber Crime, Types of Cyber Crime: crime against an individual, Crime against property, Cyber extortion, Drug trafficking, cyber terrorism. Need for Information security, Threats to Information Systems, Information Assurance, Cyber Security, and Security Risk Analysis.		
<b>#Exemplar/Case Studies</b>	Data Breach Digest – Perspective & Reality : <a href="http://verizonenterprise.com/databreachdigest">http://verizonenterprise.com/databreachdigest</a>	
<b>*Mapping of Course Outcome for Unit I</b>	CO1	
<b>Unit 2</b>	<b>Cyber Crime Issues and Cyber attacks</b>	<b>06 Hours</b>
Unauthorized Access to Computers, Computer Intrusions, Viruses, and Malicious Code, Internet Hacking and Cracking, Virus and worms, Software Piracy, Intellectual Property, Mail Bombs, Exploitation, Stalking and Obscenity in Internet, Cybercrime prevention methods, Application security (Database, E-mail, and Internet), Data Security Considerations-Backups, Archival Storage and Disposal of Data, Security Technology-Firewall and VPNs, Hardware protection mechanisms, OS Security		
<b>#Exemplar/Case Studies</b>	Cyber Stalking types & their cases respectively	
<b>*Mapping of Course Outcome for Unit II</b>	CO2	
<b>Unit 3</b>	<b>Introduction to Digital Forensics</b>	<b>06 Hours</b>
What is Computer Forensics?, Use of Computer Forensics in Law Enforcement, Computer Forensics Assistance to Human Resources/Employment Proceedings, Computer Forensics Services, Benefits of		

Professional Forensics Methodology, Steps taken by Computer Forensics Specialists Types of Computer Forensics Technology: Types of Military Computer Forensic Technology, Types of Law Enforcement — Computer Forensic Technology, Types of Business Computer Forensic Technology Computer Forensics Evidence and Capture: Data Recovery Defined, Data Back-up and Recovery, The Role of Back-up in Data Recovery, The Data-Recovery Solution.

<b>#Exemplar/Case Studies</b>	Demonstrate practice Linux networking security recovery commands.& Study Tools viz; FTK & The Sleuth Kit
<b>*Mapping of Course Outcome for Unit III</b>	CO3

<b>Unit 4</b>	<b>Evidence Collection and Data Seizure</b>	<b>06 Hours</b>
Why Collect Evidence? Collection Options ,Obstacles, Types of Evidence — The Rules of Evidence, Volatile Evidence, General Procedure, Collection and Archiving, Methods of Collection, Artifacts, Collection Steps, Controlling Contamination: The Chain of Custody Duplication and Preservation of Digital Evidence: Preserving the Digital Crime Scene — Computer Evidence Processing Steps, Legal Aspects of Collecting and Preserving Computer Forensic Evidence Computer Image Verification and Authentication: Special Needs of Evidential Authentication, Practical Consideration, Practical Implementation.		

<b>#Exemplar/Case Studies</b>	Understand how computer forensics works by visiting: <a href="http://computer.howstuffworks.com/computer-forensic.htm/printable">http://computer.howstuffworks.com/computer-forensic.htm/printable</a> (23 December 2010)
<b>*Mapping of Course Outcome for Unit IV</b>	CO4

<b>Unit 5</b>	<b>Computer Forensics analysis and validation</b>	<b>06 Hours</b>
Determining what data to collect and analyze, validating forensic data, addressing data-hiding techniques, and performing remote acquisitions Network Forensics: Network forensics overview, performing live acquisitions, developing standard procedures for network forensics, using network tools, examining the honeynet project. Processing Crime and Incident Scenes: Identifying digital evidence, collecting evidence in private-sector incident scenes, processing law enforcement crime scenes, preparing for a search, securing a computer incident or crime scene, seizing digital evidence at the scene, storing digital evidence, obtaining a digital hash, reviewing a case		

<b>#Exemplar/Case Studies</b>	Discuss cases under Financial Frauds, Matrimonial Frauds, Job Frauds, Spoofing, and Social media. Then write down safety tips, precautionary measures for the discussed fraud cases.
<b>*Mapping of Course Outcomes for Unit V</b>	CO5

<b>Unit 6</b>	<b>Current Computer Forensic tools</b>	<b>06 Hours</b>
Evaluating computer forensic tool needs, computer forensics software tools, computer forensics hardware tools, validating and testing forensics software E-Mail Investigations: Exploring the role of e-mail in investigation, exploring the roles of the client and server in e-mail, investigating e-mail crimes and violations, understanding e-mail servers, using specialized e-mail forensic tools.		

<b>#Exemplar/Case Studies</b>	Install Kali Linux & practice following examples: 1. <a href="https://www.youtube.com/watch?time_continue=6&amp;v=MZXZctqIU-w&amp;feature=emb_logo">https://www.youtube.com/watch?time_continue=6&amp;v=MZXZctqIU-w&amp;feature=emb_logo</a>
<b>*Mapping of Course Outcome for Unit VI</b>	CO6

### Learning Resources

#### Text Books:

1. John R. Vacca, "Computer Forensics", Computer Crime Investigation Firewall Media, New Delhi.
2. Nelson, Phillips Enfinger, Steuart, "Computer Forensics and Investigations", CENGAGE Learning

#### Reference Books:

1. Keith J. Jones, Richard Bejtlich, Curtis W. Rose, "Real Digital Forensics", Addison-Wesley Pearson Education

2. Tony Sammes and Brian Jenkinson, "Forensic Compiling", A Practitioner's Guide, Springer International edition.

3. Christopher L.T. Brown, "Computer Evidence Collection & Presentation", Firewall Media.

4. Jesus Mena, "Homeland Security, Techniques & Technologies", Firewall Media.

**e books:**

1.<https://www.pdfdrive.com/computer-forensics-investigating-network-intrusions-and-cyber-crime-e1585265.html>

2.<https://dokumen.pub/handbook-of-computer-crime-investigation-forensic-tools-and-technology-1stnbsped-0121631036-9780121631031.html>

3. Massachusetts Institute of Technology Open Courseware: <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-858-computer-systems-security-fall-2014/>

**MOOC Courses Links:**

- MIT Open CourseWare: <https://ocw.mit.edu/courses/>

**@The CO-PO Mapping Matrix**

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



## Savitribai Phule Pune University

### Fourth Year of Computer Engineering (2019 Course)

#### Elective III

#### 410244(D): Object oriented Modeling and Design

**Teaching Scheme:**

**TH: 03 Hours/Week**

**Credit**

**03**

**Examination Scheme:**

**In-Sem (Paper): 30 Marks**

**End-Sem (Paper): 70 Marks**

**Prerequisite Courses:** Software Engineering (210245)

**Companion Course:** Laboratory Practice IV (410247)

#### **Course Objectives:**

- Describe the concepts involved in Object-Oriented modelling and their benefits.
- Demonstrate concept of use-case model, sequence model and state chart model for a given problem.
- Explain the facets of the unified process approach to design and build a Software system.
- Translate the requirements into implementation for Object Oriented design.
- Choose an appropriate design pattern to facilitate development procedure. Select suitable design pattern depending on nature of application.
- To describe Designing and Management of Patterns.

#### **Course Outcomes:**

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

CO1: Describe the concepts of object-oriented and basic class modelling.

CO2: Draw class diagrams, sequence diagrams and interaction diagrams to solve problems.

CO3: Choose and apply a befitting design pattern for the given problem

CO4: To Analyze applications, architectural Styles & software control strategies

CO5: To develop Class design Models & choose Legacy Systems.

CO6: To Understand Design Patterns

#### **Course Contents**

<b>Unit I</b>	<b>Introduction To Modeling</b>	<b>06 Hours</b>
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What is Object Orientation? What is OO development? OO themes; Evidence for usefulness of OO development; OO modeling history Modeling as Design Technique: Modeling; abstraction; The three models. Class Modeling: Object and class concepts; Link and associations concepts; Generalization and inheritance; A sample class model; Navigation of class models; Practical tips.

<b>#Exemplar/Case Studies</b>	Case Study of ATM System
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<b>*Mapping of Course Outcomes for Unit I</b>	CO1
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<b>Unit II</b>	<b>Advanced Class Modeling and State Modeling</b>	<b>06 Hours</b>
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Advanced object and class concepts; Association ends; N-ary associations; Aggregation; Abstract classes; Multiple inheritance; Metadata; Reification; Constraints; Derived data; Packages; Practical tips. State Modeling: Events, States, Transitions and Conditions; State diagrams; State diagram

behavior; Practical tips.

<b>#Exemplar/CaseStudies</b>	Case Study of Train Reservation System	
<b>*Mapping of Course</b>	CO2	
<b>Outcomes for Unit II</b>		
<b>Unit III</b>	<b>Advanced State Modeling and Interaction Modeling</b>	<b>06 Hours</b>
Advanced State Modeling: Nested state diagrams; Nested states; Signal generalization; Concurrency; A sample state model; Relation of class and state models; Practical tips. Interaction Modeling: Use case models; Sequence models; Activity models. Use case relationships; Procedural sequence models; Special constructs for activity models.		
<b>#Exemplar/Case Studies</b>	Case Study of Coffee Vending Machine	
<b>*Mapping of Course</b>	CO2, C03	
<b>Outcomes for Unit III</b>		
<b>Unit IV</b>	<b>User Application Analysis : System Design</b>	<b>06 Hours</b>
Application Analysis: Application interaction model; Application class model; Application state model; Adding operations. Overview of system design; Estimating performance; Making a reuse plan; Breaking a system in to sub-systems; Identifying concurrency; Allocation of sub-systems; Management of data storage; Handling global resources; Choosing a software control strategy; Handling boundary conditions; Setting the trade-off priorities; Common architectural styles; Architecture of the ATM system as the example		
<b>#Exemplar/Case Studies</b>	Case System of ATM System	
<b>*Mapping of Course</b>	CO3, CO4	
<b>Outcomes for Unit IV</b>		
<b>Unit V</b>	<b>Class Design ,Implementation Modeling, Legacy Systems</b>	<b>06 Hours</b>
Class Design: Overview of class design; Bridging the gap; Realizing use cases; Designing algorithms; Recursing downwards, Refactoring; Design optimization; Reification of behavior; Adjustment of inheritance; Organizing a class design; ATM example. Implementation Modeling: Overview of implementation; Fine-tuning classes; Fine-tuning generalizations; Realizing associations; Testing. Legacy Systems: Reverse engineering; Building the class models; Building the interaction model; Building the state model; Reverse engineering tips; Wrapping; Maintenance		
<b>#Exemplar/Case Studies</b>	Case study of College Library System	
<b>*Mapping of Course</b>	CO4, CO5	
<b>Outcomes for Unit V</b>		
<b>Unit VI</b>	<b>Design Pattern</b>	<b>06 Hours</b>
What is a pattern and what makes a pattern? Pattern categories; Relationships between patterns; Patterndescription Communication Patterns: Forwarder-Receiver; Client-Dispatcher-Server; Publisher-Subscriber. Management Patterns: Command processor; View handler. Idioms: Introduction; what can idioms provide? Idioms and style; Where to find idioms; Counted Pointer example		

<b>#Exemplar/Case Studies</b>	Design Pattern for Any suitable System
<b>*Mapping of Course Outcomes for Unit VI</b>	CO6

### Learning Resources

**Text Books:**

1. Michael Blaha, James Rumbaugh, "Object-Oriented Modeling and Design with UML", 2<sup>nd</sup> Edition, Pearson Education, 2005.
2. Frank Buchmann, Regine Meunier, Hans Rohnert, Peter Sommer lad, Michael Stal, "Pattern-Oriented Software Architecture, A System of Patterns", Volume 1, John Wiley and Sons, 2007

**Reference Books:**

1. Grady Booch et al, "Object-Oriented Analysis and Design with Applications", 3rd Edition, Pearson Education, 2007
2. Brahma Dathan, Sarnath Ramnath, "Object-Oriented Analysis, Design, and Implementation", UniversitiesPress, 2009
3. Hans-Erik Eriksson, Magnus Penker, Brian Lyons, David Fado, " UML 2 Toolkit", Wiley-Dreamtech India, 2004
4. Simon Bennett, Steve McRobb and Ray Farmer, " UML 2 Toolkit, Object- Oriented Systems Analysis and Design Using UML, 2 nd Edition, Tata McGraw-Hill, 2002

**e-Books :**

1. [Object Oriented Modeling and Design - https://www.pdfdrive.com/object-oriented-design-and-modeling-d10014860.html](https://www.pdfdrive.com/object-oriented-design-and-modeling-d10014860.html)
2. <https://www.gopalancolleges.com/gcem/course-material/computer-science/course-plan/sem-VII/object-oriented-modeling-and-design-10CS71.pdf>

**MOOC Lectures Links:**

- <https://nptel.ac.in/courses/106105153>

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

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



## Savitribai Phule Pune University

### Fourth Year of Computer Engineering (2019 Course)

#### Elective III

#### 410244(E): Digital Signal Processing

**Teaching Scheme:**

**TH: 03 Hours/Week**

**Credit  
03**

**Examination Scheme:**

**In-Sem (Paper): 30 Marks**

**End-Sem (Paper): 70 Marks**

**Prerequisite Courses:** Engineering Mathematics III(207003)

**Companion Course:** Laboratory Practice IV(410247)

**Course Objectives:**

- To Study and understand representation and properties of signals and systems.
- To learn methodology to analyze signals and systems
- To study transformed domain representation of signals and systems
- To explore Design and analysis of Discrete Time (DT) signals and systems
- To Understand Design of filters as DT systems
- To get acquainted with the DSP Processors and DSP applications

**Course Outcomes:**

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

CO1: Understand the mathematical models and representations of DT Signals and Systems

CO2: Apply different transforms like Fourier and Z-Transform from applications point of view.

CO3: Understand the design and implementation of DT systems as DT filters with filter structuresand different transforms.

CO4: Demonstrate the knowledge of signals and systems for design and analysis of systems

CO5: Apply knowledge and use the signal transforms for digital processing applications

CO6:To understand Filtering and Different Filter Structures

#### Course Contents

Unit I	Signals and Systems	08 Hours
Continuous time (CT), Discrete-time (DT) and Digital signals, Basic DT signals and Operations. Discrete-time Systems, Properties of DT Systems and Classification, Linear Time Invariant (LTI) Systems, Impulse response, Linear convolution, Linear constant coefficient difference equations, FIR and IIR systems, Periodic Sampling, Relationship between Analog and DT frequencies, Aliasing, Sampling Theorem, A to D conversion Process: Sampling, quantization and encoding		
<b>#Exemplar/Case Studies</b>	Audio/Music Sampling	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1	
Unit II	Frequency Domain Representation of Signal	08 Hours
Introduction to Fourier Series, Representation of DT signal by Fourier Transform (FT), Properties of FT: Linearity, periodicity, time shifting, frequency shifting, time reversal, differentiation, convolution theorem, windowing theorem Discrete Fourier Transform (DFT), DFT		

and FT, IDFT, Twiddle factor, DFT as linear transformation matrix, Properties of DFT, circular shifting, Circular Convolution, DFT as Linear filtering, overlap save and add, DFT spectral leakage

<b>#Exemplar/Case Studies</b>	Spectral Analysis using FFT
<b>*Mapping of Course</b>	CO1
<b>Outcomes for Unit II</b>	

<b>Unit III</b>	<b>Fast Fourier Transform (FFT) and Z-Transform(ZT)</b>	<b>08 Hours</b>
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Effective computation of DFT, Radix-2 FFT algorithms: DIT FFT, DIF FFT, Inverse DFT using FFT, Z-transform (ZT), ZT and FT, ZT and DFT, ROC and its properties, ZT Properties, convolution, initial value theorem, Rational ZT, Pole Zero Plot, Behavior of causal DT signals, Inverse Z Transform (IZT): power series method, partial fraction expansion (PFE) , Residue method.

<b>#Exemplar/Case Studies</b>	Discrete Hilbert Algorithm
<b>*Mapping of Course</b>	CO2
<b>Outcomes for Unit III</b>	

<b>Unit IV</b>	<b>Analysis of DT - LTI Systems</b>	<b>08 Hours</b>
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System function  $H(z)$ ,  $H(z)$  in terms of Nth order general difference equation, all poll and all zero systems, Analysis of LTI system using  $H(Z)$ , Unilateral Z-transform: solution of difference equation, Impulse and Step response from difference equation, Pole zero plot of  $H(Z)$  and difference equation, Frequency response of system, Frequency response from pole-zero plot using Simple geometric construction.

<b>#Exemplar/Case Studies</b>	Schur Algorithm
<b>*Mapping of Course</b>	CO3
<b>Outcomes for Unit IV</b>	

<b>Unit V</b>	<b>Digital Filter Design</b>	<b>08 Hours</b>
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Concept of filtering, Ideal filters and approximations, specifications, FIR and IIR filters, Linear phase response, FIR filter Design: Fourier Series method, Windowing method, Gibbs Phenomenon, desirable features of windows, Different window sequences and its analysis, Design examples IIR filter design: Introduction, Mapping of S-plane to Z-plane, Impulse Invariance method, Bilinear Z transformation (BLT) method, Frequency Warping, Pre-warping, Design examples, Comparison of IIR and FIR Filters.

<b>#Exemplar/Case Studies</b>	Realization of an Analogue Second-order Differentiator
<b>*Mapping of Course</b>	CO5
<b>Outcomes for Unit V</b>	

<b>Unit VI</b>	<b>Filter Structures and DSP Processors</b>	<b>08 Hours</b>
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Filter Structures for FIR Systems: direct form, cascade form, structures for linear phase FIR Systems, Examples, Filter structures for IIR Systems: direct form, cascade form, parallel form, Examples DSP Processors: ADSP 21XX Features, comparison with conventional processor, Basic Functional Block diagram, SHARC DSP Processor Introduction to OMAP (Open Multimedia Application Platform).

<b>#Exemplar/Case Studies</b>	Architectures and Design techniques for energy efficient embedded DSP
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	and multimedia processing
<b>*Mapping of Course Outcomes for Unit VI</b>	CO6

**Learning Resources****Text Books:**

1. Proakis J, Manolakis D, "Digital Signal Processing", 4th Edition, Pearson Education, ISBN9788131710005
2. Oppenheim A, Schafer R, Buck J, "Discrete time Signal Processing", 2nd Edition, Pearson Education, ISBN 9788131704929

**Reference Books:**

1. Mitra S., "Digital Signal Processing: A Computer Based Approach", Tata McGraw-Hill, 1998, ISBN 0-07-044705-5
2. Ifleachor E. C., Jervis B. W., "Digital Signal Processing: A Practical Approach", Pearson-Education, 2002, ISBN-13: 978-0201596199, ISBN-10: 0201596199
3. S. Salivahanan, A. Vallavaraj, C. Gnanapriya, "Digital Signal Processing", McGraw-Hill, ISBN 0-07-463996-X
4. S. Poornachandra, B. Sasikala, "Digital Signal Processing", 3rd Edition, McGraw-Hill, ISBN-13: 978-07-067279-6

**e-Books :**

1. An Introduction to Digital Signal Processing: A Focus on Implementation  
[https://www.riverpublishers.com/pdf/ebook/RP\\_E9788792982032.pdf](https://www.riverpublishers.com/pdf/ebook/RP_E9788792982032.pdf)

**MOOC Courses Links:**

- Digital signal Processing Introduction- <https://nptel.ac.in/courses/117102060>

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective IV**  
**410245(A): Information Retrieval**

<b>Teaching Scheme:</b> TH: 03 Hours/Week	<b>Credit</b> <b>03</b>	<b>Examination Scheme:</b> <b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>
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**Prerequisite Courses:** Database Management Systems(310241)

**Companion Course:** Laboratory Practice IV(410247)

**Course Objectives:**

- To study basic concepts of Information Retrieval.
- To study concepts of Indexing for Information Retrieval.
- To analyze the performance of information retrieval using advanced techniques such as classification, clustering, and filtering over multimedia.
- To provide comprehensive details about various Evaluation methods.
- To understand the changes necessary to transfer a Basic IR system into large scale search service system.
- To understand Parallel Information retrieval and Web structures .

**Course Outcomes:**

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

CO1:Implement the concept of Information Retrieval

CO2:Generate quality information out of retrieved information

CO3:Apply techniques such as classification, clustering, and filtering over multimedia to analyzethe information

CO4:Evaluate and analyze retrieved information

CO5:Understand the data in various Application and Extensions of information retrieval

CO6: Understand Parallel information retrieving and web structure.

**Course Contents**

<b>Unit I</b>	<b>Introduction , Basic techniques, &amp;Token</b>	<b>07 Hours</b>
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**Introduction:** The IR System, The Software Architecture Of The IR System.

**Basic IR Models:** Boolean Model, TF-IDF (Term Frequency/Inverse Document Frequency) Weighting, Vector Model, Probabilistic Model and Latent Semantic Indexing Model.

**Basic Tokenizing:** Simple Tokenizing, Stop-Word Removal and Stemming.

<b>#Exemplar/Case Studies</b>	A Case Study Of Onitsha Divisional Library Which Aims At Finding TheCauses And Solutions To The Problems Of Information Retrieval Methods By The Library.
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<b>*Mapping of Course Outcomes for Unit I</b>	CO 1
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<b>Unit II</b>	<b>Static Inverted Indices and Query Processing</b>	<b>07 Hours</b>
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**Static Inverted Indices :Inverted Index Construction, Index Components and Index Life Cycle, The Dictionary :** Sort-based dictionary ,Hash-based dictionary, Interleaving Dictionary and Postings Lists,

**Index Construction:** Different types of Index Construction, In-Memory Index Construction, Sort-Based Index Construction, Merge-Based Index Construction, Disk-Based Index Construction),

### Other types of Indices.

**Query Processing :** 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, Lightweight Structure :** Generalized Concordance Lists, Operators, Implementation & Examples

<b>#Exemplar/CaseStudies</b>	Match the search statement with the stored database
<b>*Mapping of Course Outcomes for Unit II</b>	CO2
<b>Unit III Index Compression and Dynamic Inverted Indices</b>	<b>07 Hours</b>

General-Purpose Data Compression,

**Data Compression :** Modeling and Coding, Huffman Coding, Arithmetic Coding, Symbolwise Text Compression

### Compressing Postings Lists:

Nonparametric Gap Compression, Parametric Gap Compression, Context-Aware Compression Methods, Index Compression for High Query Performance, Compression Effectiveness, Decoding Performance, Document Reordering.

### Dynamic Inverted Indices:

Incremental Index Updates, Contiguous Inverted Lists, Noncontiguous Inverted,

**Document Deletions:** Invalidations List, Garbage Collection, Document Modifications,

<b>#Exemplar/Case Studies</b>	Translating Short Segments with NMT: A Case Study in English-to-Hindi
<b>*Mapping of Course Outcomes for Unit III</b>	CO2
<b>Unit IV Probabilistic Retrieval and Language Modeling &amp; Related Methods , Categorization &amp; Filtering</b>	<b>07 Hours</b>

**Probabilistic Retrieval:** Modeling Relevance, The Binary Independence Model, Term Frequency, Document Length: BM25, Relevance Feedback, Field Weights; **Language Modeling and Related Methods:** Generating Queries from Documents, Language Models and Smoothing, Ranking with Language Models, Divergence from Randomness, Passage Retrieval and Ranking

**Categorization and Filtering:** Detailed Examples, Classification, Linear, Similarity- Based, Probabilistic Classifiers, Generalized Linear Models. Information-Theoretic Model.

<b>#Exemplar/Case Studies</b>	E-Mail on the Move: Study of E-mail Categorization, Filtering, and Alerting on Mobile Devices
<b>*Mapping of Course Outcomes for Unit IV</b>	CO3
<b>Unit V Measuring Effectiveness and Measuring Efficiency</b>	<b>07 Hours</b>

**Measuring Effectiveness** - Traditional effectiveness measure, The Text Retrieval Conference (TREC), Using statistics in evaluation, Minimizing adjudication Effort, Nontraditional effectiveness measures, **Measuring Efficiency** – Efficiency criteria, Query Scheduling, Caching, Introduction to Redis and Memcached

<b>#Exemplar/Case Studies</b>	Study of API Handling	
<b>*Mapping of Course Outcomes for Unit V</b>	CO4	
<b>Unit VI</b>	<b>Parallel Information retrieval , Web Search</b>	<b>07 Hours</b>
<b>Parallel Information retrieval - Parallel Query Processing, MapReduce</b>		
<b>Web Search-</b> The structure of the web, Quires and Users, Static ranking, Dynamic ranking, Evaluation web search, Web Crawlers, Web crawler libraries, Python Scrapy, Beautiful Soup		
<b>#Exemplar/Case Studies</b>	Study of Google Map / Facebook information retrieval	
<b>*Mapping of Course Outcomes for Unit VI</b>	CO5, CO6	

### Learning Resources

#### Text Books:

1. S. Buttcher, C. Clarke and G. Cormack, "Information Retrieval: Implementing and Evaluating Search Engines" MIT Press, 2010, ISBN: 0-408-70929-4.
2. C. Manning, P. Raghavan, and H. Schütze, "Introduction to Information Retrieval", Cambridge University Press, 2008, -13: 9780521865715
3. Ricardo Baeza , Yates and Berthier Ribeiro Neto, "Modern Information Retrieval: The Concepts and Technology behind Search", 2nd Edition, ACM Press Books 2011.
4. Bruce Croft, Donald Metzler and Trevor Strohman, "Search Engines: Information Retrieval in Practice", 1st Edition Addison Wesley, 2009, ISBN: 9780135756324

#### Reference Books:

1. C.J. Rijsbergen, "Information Retrieval", (<http://www.dcs.gla.ac.uk/Keith/Preface.html>)
2. W.R. Hersh, "Information Retrieval: A Health and Biomedical Perspective", Springer, 2002.
3. G. Kowalski, M.T. Maybury. "Information storage and Retrieval System" , Springer, 2005
4. W.B. Croft, J. Lafferty, "Language Modeling for Information Retrieval", Springer, 2003

#### e-Books :

1. Information Retrieval- [www.informationretrieval.org](http://www.informationretrieval.org)

#### MOOC Courses Links:

- <https://nptel.ac.in/courses/117102060>

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective IV**

**410245(B): GPU Programming and Architecture**

<b>Teaching Scheme:</b> TH: 03Hours/Week	<b>Credit</b> 03	<b>Examination Scheme:</b> <b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>
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**Prerequisites Courses:** Computer Graphics(210244)

**Companion Course:** Laboratory Practice IV(410247)

**Course Objectives:**

- To Understand Graphics Processing Unit (GPU) Concepts.
- To understand the basics of GPU architectures
- To write programs for massively parallel processors
- To understand the issues in mapping algorithms for GPUs
- To introduce different GPU programming models
- To examine the architecture and capabilities of modern GPUs.

**Course Outcomes:**

After completion of the course, students should be able to-

**CO1:** Describe GPU architecture

**CO2:** Write programs using CUDA, identify issues and debug them.

**CO3:** Implement efficient algorithms in GPUs for common application kernels, such as matrix multiplication

**CO4:** Write simple programs using OpenCL

**CO5:** Identify efficient parallel programming patterns to solve problems

**CO6:** Explore the modern GPUs architecture and it's Applications.

**Course Contents**

<b>Unit I</b>	<b>Introduction to Graphics Processing Unit (GPU)</b>	<b>07 Hours</b>
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.		
<b>#Exemplar/Case Studies</b>	Review of traditional Computer Architecture	
<b>*Mapping of Course Outcomes for Unit I</b>	CO 1	
<b>Unit II</b>	<b>Cuda Programming</b>	<b>07 Hours</b>
Using CUDA – Multi GPU – Multi GPU Solutions – Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions.		
<b>#Exemplar/Case Studies</b>	Write basic CUDA programs.	
<b>*Mapping of Course Outcomes for Unit II</b>	CO 2	
<b>Unit III</b>	<b>Programming Issues</b>	<b>07 Hours</b>

Common Problems: CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors.

<b>#Exemplar/Case Studies</b>	Study of various CUDA errors
<b>*Mapping of Course Outcomes for Unit III</b>	CO 3

<b>Unit IV</b>	<b>OpenCL Basics</b>	<b>07 Hours</b>
OpenCL Standard, Kernels, Host Device Interaction, Execution Environment, Memory Model, Basic OpenCL Examples.		

<b>#Exemplar/Case Studies</b>	Write OpenCL basic program
<b>*Mapping of Course Outcomes for Unit IV</b>	CO 4

<b>Unit V</b>	<b>Algorithms on GPU</b>	<b>07 Hours</b>
Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix – Matrix Multiplication – Programming Heterogeneous Cluster		

<b>#Exemplar/Case Studies</b>	Describe multi-dimensional mapping of dataspace.
<b>*Mapping of Course Outcomes for Unit V</b>	CO 5

<b>Unit VI</b>	<b>OpenCL and Application Design</b>	<b>07 Hours</b>
OpenCL for Heterogeneous Computing, Application Design : Efficient Neural Network Training/Inferencing		

<b>#Exemplar/Case Studies</b>	Describe OpenCL for Heterogeneous computing
<b>*Mapping of Course Outcomes for Unit VI</b>	CO6

### **Learning Resources**

#### **Text Books:**

- Shane Cook, “CUDA Programming: A Developer’s Guide to Parallel Computing with GPUs (Applications of GPU Computing)”, First 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,Lee Howes, David R. Kaeli, “Heterogeneous Computing with OpenCL”

#### **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 GPUProgramming”, Addison – Wesley, 2010.
- David B. Kirk, Wen-mei W. Hwu, “Programming Massively Parallel Processors “, A Hands-onApproach, Third Edition, Morgan Kaufmann, 2016.
- [http://www.nvidia.com/object/cuda\\_home\\_new.html](http://www.nvidia.com/object/cuda_home_new.html)
- <http://www.openCL.org>

**e-Books :**

1. <https://www.perlego.com/book/1418742/cuda-handbook-a-comprehensive-guide-to-gpu-programming-the-pdf>

**NPTEL/YouTube video lecture link**

- [https://onlinecourses.nptel.ac.in/noc20\\_cs41/preview](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	2	-	1	-	-	-	-	-
CO2	1	2	2	2	2	-	-	-	-	-	-	-
CO3	1	2	2	2	2	-	-	-	-	-	-	-
CO4	1	2	2	2	2	-	-	-	-	-	-	-
CO5	1	2	2	2	2	-	-	-	-	-	-	-
CO6	1	2	2	1	2	-	-	-	-	-	-	-



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective IV**  
**410245(C ): Mobile Computing**

<b>Teaching Scheme:</b> TH: 3 Hours/Week	<b>Credit</b> <b>3</b>	<b>Examination Scheme:</b> <b>In-Sem (TH) : 30 Marks</b> <b>End-Sem (TH): 70 Marks</b>
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**Prerequisites Courses:** Computer Networks and Security(310244)

**Companion Course:** Laboratory Practice IV(410247)

**Course Objectives:**

- To introduce the basic concepts and principles in mobile computing. This includes major techniques involved, and networks & systems issues for the design and implementation of mobile computing systems and applications
- To demonstrate the protocols of mobile communication.
- To know GSM architecture and support services
- To Study on location, handoff management and wireless fundamentals.
- To summarize VLR and HLR identification algorithms
- To learn current technologies being used on field and design and development of various network protocol using simulation tools.

**Course Outcomes:**

CO1: Develop a strong grounding in the fundamentals of mobile Networks

CO2: Apply knowledge in MAC, Network, and Transport Layer protocols of Wireless Network

CO3: Illustrate Global System for Mobile Communications

CO4: Use the 3G/4G technology based network with bandwidth capacity planning, VLR and HLR identification algorithms

CO5: Classify network and transport layer of mobile communication

CO6: Design & development of various wireless network protocols using simulation tools

**Course Contents**

<b>Unit I</b>	<b>Introduction to Mobile Computing</b>	<b>07 Hours</b>
Introduction to Mobile computing, Constraints in mobile computing, Application of mobile computing, Generations of mobile wireless 1G to 5G, Future of mobile computing, Radio frequency Technology, Public Switched Telephone network, (PSTN), Public Communication service (PCS), PCS Architecture, , Blue tooth, Ad-hoc Networks.		
<b>#Exemplar/Case Studies</b>	5G Network , Spectrum sharing for D2D communication in 5G cellular networks	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1	
<b>Unit II</b>	<b>Mobile Wireless protocols</b>	<b>07 Hours</b>
Introduction of WAP, WAP applications, WAP Architecture, WAP Protocol Stack, Challenges in WAP . Introduction, Benefits, Difference, Routing protocols for ad hoc wireless networks: DSDV and AODV, Wireless Application protocols: MAC,SDMA, FDMA,TDMA,CDMA, Cellular Wireless Networks. Wireless Communication: Cellular systems, Frequency Management and Channel Assignment Types of handoff		

and their characteristics.

<b>#Exemplar/Case Studies</b>	IPoC: A New Core Networking Protocol for 5G Networks.	
<b>*Mapping of Course Outcomes for Unit II</b>	CO2	
<b>Unit III</b>	<b>Global System for Mobile Communication</b>	<b>07 Hours</b>
Global System for Mobile Communications (GSM) architecture , Mobile Station, Base Station System, Switching subsystem, Security, Data Services, HSCSD, GPRS - GPRS system and protocol architecture 2.3 UTRAN, UMTS core network; Improvements on Core Network, 802.11 Architecture 802.11a, 802.11b standard		
<b>#Exemplar/Case Studies</b>	5G mobile communications	
<b>*Mapping of Course Outcomes for Unit III</b>	CO3	
<b>Unit IV</b>	<b>GSM Networking Signaling and Mobile Management</b>	<b>07 Hours</b>
GSM MAP Service framework, MAP protocol machine, GSM location management, Transaction management, Mobile database, Introduction to location management HLR and LR VLR and HLR Failure restoration, VLR identification algorithm, O-I, O-II algorithm etc. Overview of handoff process; Factors affecting handoffs and performance evaluation metrics; Handoff strategies; Different types of handoffs (soft, hard, horizontal, vertical).		
<b>#Exemplar/Case Studies</b>	5G Mobility Management , Micro Mobility: CellularIP, HAWAII, HMIPv6	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO4	
<b>Unit V</b>	<b>Mobile Network and Transport Layers</b>	<b>07 Hours</b>
Mobile IP , IP packet delivery, Tunnelling and encapsulation, IPv6, DHCP, Vehicular Ad Hoc networks ( VANET), MANET , Traditional TCP, Snooping TCP, Mobile TCP, 3G wireless network, Wireless Application Protocol, WDP WTP, WML, WTA architecture, Cellular IP		
<b>#Exemplar/Case Studies</b>	5G Network and Transport Layers	
<b>*Mapping of Course Outcomes for Unit V</b>	CO5	
<b>Unit VI</b>	<b>3G and 4G Technologies</b>	<b>07 Hours</b>
3G and 4G Technologies for GSM and CDMA; W-CDMA, UMTS, HSPA (High Speed Packet Access), HSDPA, HSUPA, HSPA+, TD-SCDMA, LTE (E-UTRA) 3GPP2 family CDMA2000 1x, 1xRTT, EV-DO (Evolution-Data Optimized), Long Term Evolution (LTE) in 4G. Architecture of 5G. Role of 5G in IoT.		

#Exemplar/Case Studies	Long-Term Evolution (LTE) of 3GPP
*Mapping of Course Outcomes for Unit VI	CO6
<b>Learning Resources</b>	

**Text Books:**

1. Jochen Schiller, "Mobile Communications", Pearson Education, 2009.
2. Martin Sauter, "3G, 4G and Beyond: Bringing Networks, Devices and the Web Together", 2012, ISBN-13: 978-1118341483
3. Raj Kamal, "Mobile Computing", 2/e, Oxford University Press

**Reference Books :**

1. William Stallings, "Wireless Communications & Networks", Second Edition, Pearson Education
2. Christopher Cox, "An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications", Wiley publications
3. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2012.

**e-Books :**

1. <http://www.dauniv.ac.in/downloads/Mobilecomputing/Microsoft%20%20MobileCompChap02L02HandelCompanMobileOSes.pdf>

**MOOC Courses Links :**

- <https://nptel.ac.in/courses/106106147>

**@The CO-PO Mapping Matrix**

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective IV**

**410245 (D): Software Testing and Quality Assurance**

**Teaching Scheme:**

**TH: 03 Hours/Week**

**Credit**

**03**

**Examination Scheme:**

**In-Sem (Paper): 30 Marks**

**End-Sem (Paper): 70 Marks**

**Prerequisite Courses:** Software Engineering (210253), Software Project Management(310245(D))

**Companion Course: Lab Practice IV**

**Course Objectives:**

- Introduce basic concepts of software testing.
- Understand the best way to increase the effectiveness, test coverage, and execution speed in software testing.
- Understand white box, block box, object oriented, web based and cloud testing.
- Understand the importance of software quality and assurance software systems development.
- Know in details automation testing and tools used for automation testing.
- To learn and understand the combination of practices and tools that are designed to help QA professionals test more efficiently.

**Course Outcomes:**

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

**CO1: Describe** fundamental concepts in software testing such as manual testing, automation testing and software quality assurance.

**CO2: Design and Develop** project test plan, design test cases, test data, and conduct test operations.

**CO3: Apply** recent automation tool for various software testing for testing software.

**CO4: Apply** different approaches of quality management, assurance, and quality standard to software system.

**CO5: Apply** and analyze effectiveness Software Quality Tools.

**CO6: Apply** tools necessary for efficient testing framework.

**Course Contents**

**Unit I**

**Introduction to Software Testing**

**07 Hours**

**Introduction:** historical perspective, Definition, Core Components, Customers suppliers and process, Objectives of Testing, Testing and Debugging, Need of Testing, Quality Assurance and Testing, Why Software has Errors, Defects and Failures and its Causes and Effects, Total Quality Management(TQM), Quality practices of TQM, Quality Management through- Statistical process Control, Cultural Changes, Continual Improvement cycle, Benchmarking and metrics, Problem Solving Techniques and Software Tools. Software Quality, Constraints of Software product Quality assessment, Quality and Productivity Relationship, Requirements of Product, Software Development Process, Types of Products, Software Development Lifecycle Models, Software Quality Management, Processes related to Software Quality, Quality Management System's Structure, Pillars of Quality Management System, Important aspects of quality management.

**#Exemplar/Case Studies**

1. Offshore delivery model for an Airline Company.
2. SAP test automation CoE for Financial Service Provider.

<b>*Mapping of Course Outcomes for Unit I</b>	CO1	
<b>Unit II</b>	<b>Test Planning and Quality Management</b>	<b>07 Hours</b>
<b>Test Planning</b> –Artifacts, Strategy, Test Organization –Test Manager & Tester Role, Test plan purpose & contents, Test Strategy and Approach, Test cases & Test Data, Test Entry-Exit criteria, Test Execution Schedule, Use case Testing, Scenario Testing, Test Monitoring & Control- Test Metrics –Test Case Productivity, Test case Coverage, Defect Acceptance & Rejection, Test Efficiency, Efforts and Schedule Variance, Test Efforts biasing Factors, Test Report & configuration Management, Quality Assurance Process, Documentation Risk & Issues. Software Quality, Quality Management Importance, Quality Best practices.		
<b>#Exemplar/CaseStudies</b>	1. Online Recommendation System 2. <a href="#">Quality Engineering services for Medical Devices company   CaseStudy (cigniti.com)</a>	
<b>*Mapping of Course Outcomes for Unit II</b>	CO2	
<b>Unit III</b>	<b>Test Case Design Techniques</b>	<b>07 Hours</b>
<p><b>Software Testing Methodologies:</b> White Box Testing, Black Box Testing, Grey Box Testing. Test Case Design Techniques: Static Techniques: Informal Reviews, Walkthroughs, Technical Reviews, Inspection. Dynamic Techniques: Structural Techniques: Statement Coverage Testing, Branch Coverage Testing, Path Coverage Testing, Conditional Coverage Testing, Loop Coverage Testing. Black Box Techniques: Boundary Value Analysis, Equivalence Class Partition, State Transition Technique, Cause Effective Graph, Decision Table, Use Case Testing, Experienced Based Techniques: Error guessing, Exploratory testing</p> <p><b>Levels of Testing:</b> Functional Testing: Unit Testing, Integration Testing, System Testing, User Acceptance Testing, Sanity/Smoke Testing, Regression Test, Retest. Non-Functional Testing: Performance Testing, Memory Test, Scalability Testing, Compatibility Testing, Security Testing, Cookies Testing, Session Testing, Recovery Testing, Installation Testing, Adhoc Testing, Risk Based Testing, I18N Testing, L1ON Testing, Compliance Testing.</p> <p>Link:<a href="https://www.besanttechnologies.com/training-courses/software-testing-training/manual-testing-training-institute-in-chennai">https://www.besanttechnologies.com/training-courses/software-testing-training/manual-testing-training-institute-in-chennai</a></p>		
<b>#Exemplar/Case Studies</b>	1. Case Study: Manual Testing (Online Marketing SoftwarePlatform)  Link: <a href="https://www.360logica.com/blog/case-study-manual-testing-online-marketing-software-platform/">https://www.360logica.com/blog/case-study-manual-testing-online-marketing-software-platform/</a>  2. Case Study: Decision Table Testing (transferring money online to an account which is already added and approved.)	
<b>*Mapping of Course Outcomes for Unit III</b>	CO3	
<b>Unit IV</b>	<b>Software Quality Assurance and Quality Control</b>	<b>07 Hours</b>
<b>Software Quality Assurance:</b> Introduction, Constraints of Software Product Quality Assessment, Quality and Productivity Relationship, Requirements of a Product, Characteristics of Software,		

Software Development Process, Types of Products, Schemes of Criticality Definitions, Software Quality Management, Why Software Has Defects? Processes Related to Software Quality, Quality Management System Structure, Pillars of Quality Management System, Important Aspects of Quality Management.

**Software Quality Control:** Software quality models, Quality measurement and metrics, Quality plan, implementation and documentation, Quality tools including CASE tools, Quality control and reliability of quality process, Quality management system models, Complexity metrics and Customer Satisfaction, International quality standards – ISO, CMM

<b>#Exemplar/Case Studies</b>	<ol style="list-style-type: none"> <li>1. Case Study #1 – Android Application Acceptance Test Suite</li> <li>2. Case Study #2 – API Acceptance Test Suite</li> </ol> <p>Link for above case studies - <a href="#">Software Quality Assurance Case Studies - Beta Breakers</a></p>
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<b>*Mapping of Course Outcomes for Unit IV</b>	CO4
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Unit V	Automation Testing Tools/Performance Testing Tools	07 Hours
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**Automation Testing:** What is automation testing, Automated Testing Process, Automation Frameworks, Benefits of automation testing, how to choose automation testing tools. Selenium Automation Tools: Selenium's Tool Suite- Selenium IDE, Selenium RC, Selenium Web driver, Selenium Grid. Automation Tools: SoapUI, Robotic Process Automation (RPA), Tosca, Appium.

[Performance Testing : What is Performance Testing what is use of it? Tools used for performance testing - Apache Jmeter.](#)

<b>#Exemplar/Case Studies</b>	<ol style="list-style-type: none"> <li>1. Case Study: Cucumber open-source automation testing framework.</li> <li>2. Case Study: <a href="#">(PDF) Automated Software Testing—A Case Study(researchgate.net)</a></li> </ol>
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<b>*Mapping of Course Outcomes for Unit V</b>	CO5
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Unit VI	Testing Framework	07 Hours
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**Testing Framework:** Software Quality, Software Quality Dilemma, Achieving Software Quality, Software Quality Assurance Elements of SQA, SQA Tasks, Goals and Metrics, Formal Approaches to SQA, Statistical Software Quality Assurance, Six Sigma for Software Engineering, ISO 9000 Quality Standards, SQA Plan, Total Quality Management, Product Quality Metrics, In process Quality Metrics, Software maintenance, Ishikawa's 7 basic tools, Flow Chart, Checklists, Pareto diagrams, Histogram, Run Charts, Scatter diagrams, Control chart, Cause Effect diagram. Defect Removal Effectiveness and Process.

<b>#Exemplar/Case Studies</b>	<ol style="list-style-type: none"> <li>1. Case study: Software Quality In Academic Curriculum.</li> <li>2. Case study: <a href="#">Evaluation of an Automated Testing Framework: A Case Study (scielo.sa.cr)</a></li> </ol>
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<b>*Mapping of Course Outcomes for Unit VI</b>	CO6
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### Learning Resources

**Text Books:**

1. M G Limaye, "Software Testing Principles, Techniques and Tools", Tata McGraw Hill, ISBN:9780070139909 0070139903
2. Srinivasan Desikan, Gopal Swamy Ramesh, "Software Testing Principles and Practices", Pearson,ISBN-10: 817758121X

**Reference Books:**

1. Naresh Chauhan, "Software Testing Principles and Practices", OXFORD, ISBN-10: 0198061846. ISBN-13: 9780198061847
2. Stephen Kan, "Metrics and Models in Software Quality Engineering", Pearson, ISBN-10: 0133988082; ISBN-13: 978-0133988086

**e-Books :**

1. M G Limaye, "Software Testing Principles, Techniques and Tools"  
[https://books.google.co.in/books?id=zUm8My7SiakC&printsec=frontcover&source=gb\\_ge\\_summary\\_r&cad=0#v=onepage&q&f=false](https://books.google.co.in/books?id=zUm8My7SiakC&printsec=frontcover&source=gb_ge_summary_r&cad=0#v=onepage&q&f=false)
2. Srinivasan Desikan, Gopalswamy Ramesh, "Software Testing Principles and Practices"  
[https://kupdf.net/queue/software-testing-principles-and-practices-by-srinivasan\\_5b0ae8eae2b6f51f7d862d26\\_pdf?queue\\_id=-1&x=1656562364&z=MTE1LjI0Mi4yNDIuNzA=](https://kupdf.net/queue/software-testing-principles-and-practices-by-srinivasan_5b0ae8eae2b6f51f7d862d26_pdf?queue_id=-1&x=1656562364&z=MTE1LjI0Mi4yNDIuNzA=)
3. Naresh Chauhan, "Software Testing Principles and Practice"  
<https://pdfcoffee.com/download/se-4-pdf-free.html>

**MOOC Courses Links:**

- <https://nptel.ac.in/courses/106105150>
- [NPTEL : NOC: Software Testing \(2017\) \(Computer Science and Engineering\) \(digimat.in\)](#)

**@The CO-PO Mapping Matrix**

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



## Savitribai Phule Pune University

### Fourth Year of Computer Engineering (2019 Course)

#### Elective IV

#### 410245(E): Compilers

<b>Teaching Scheme:</b>	<b>Credit</b> <b>03</b>	<b>Examination Scheme:</b> <b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>
<b>TH: 03 Hours/Week</b>		

**Prerequisite Courses:** Theory of Computation(310241), Systems Programming and Operating System (310251)

**Companion Course :**Laboratory Practice IV (410247)

#### **Course Objectives:**

- To aware about language translation theories and compiler design stages
- To illustrate the various parser configurations
- To exemplify the use of syntax directed translation in intermediate code
- To Understand Storage Management and Control Structure Environment .
- Learn to develop a Code generator
- To demonstrate the numerous optimization methods used in the creation of different optimizing compilers

#### **Course Outcomes:**

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

CO1: **Design** and **implement** a lexical analyzer using LEX tools

CO2: **Design** and **implement** a syntax analyzer using YACC tools

CO3:**Understand** syntax-directed translation and run-time environment

CO4 : **Generate** intermediate codes for high-level statements.

CO5 :**Construct** algorithms to produce computer code.

CO6: **Analyze and transform** programs to improve their time and memory efficiency

#### **Course Contents**

<b>Unit I</b>	<b>Notion and Concepts</b>	<b>08 Hours</b>
Introduction to compilers Design issues, passes, phases, symbol table Preliminaries Memory management, Operating system support for compiler, Lexical Analysis Tokens, Regular Expressions, Process of Lexical analysis, Block Schematic, Automatic construction of lexical analyzer using LEX, LEX features and specification.		
<b>#Exemplar/Case Studies</b>	Study of LEX Compiler	
<b>*Mapping of Course Outcomes for Unit</b>	CO1	

<b>Unit II</b>	<b>Parsing</b>	<b>08 Hours</b>
Syntax Analysis CFG, top-down and bottom-up parsers, RDP, Predictive parser, SLR, LR(1), LALR parsers, using ambiguous grammar, Error detection and recovery, automatic construction of parsers using YACC, Introduction to Semantic analysis, Need of semantic analysis, type checking and type conversion.		
Syllabus for Fourth Year of Computer Engineering		#48/128

<b>#Exemplar/Case Studies</b>	Study of YAAC	
<b>*Mapping of Course Outcomes for Unit II</b>	CO2	
<b>Unit III</b>	<b>Syntax Translation Schemes</b>	<b>08 Hours</b>
	Syntax Directed Translation - Attribute grammar, S and L attributed grammar, bottom up and top down evaluations of S and L attributed grammar, Syntax directed translation scheme, Intermediate code - need, types: Syntax Trees, DAG, Three-Address codes: Quadruples, Triples and Indirect Triples, Intermediate code generation of declaration statement and assignment statement.	
<b>#Exemplar/Case Studies</b>	Applications of Syntax Directed Translation	
<b>*Mapping of Course Outcomes for Unit III</b>	CO3	
<b>Unit IV</b>	<b>Run-time Storage Management</b>	<b>08 Hours</b>
	Storage Management – Static, Stack and Heap, Activation Record, static and control links, parameter passing, return value, passing array and variable number of arguments, Static and Dynamic scope, Dangling Pointers, translation of control structures – if, if-else statement, Switch-case, while, do -while statements, for, nested blocks, display mechanism, array assignment, pointers, function call and return. Translation of OO constructs: Class, members and Methods.	
<b>#Exemplar/Case Studies</b>	CARAT - Compiler and runtime based address translation model	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO4	
<b>Unit V</b>	<b>Code Generation</b>	<b>07 Hours</b>
	Code Generation - Issues in code generation, basic blocks, flow graphs, DAG representation of basic blocks, Target machine description, peephole optimization, Register allocation and Assignment, Simple code generator, Code generation from labeled tree, Concept of code generator.	
<b>#Exemplar/Case Studies</b>	Code Generator for a Virtual Machine Code based JavaScript Compiler ( <a href="http://article.nadiapub.com/IJAST/vol119/11.pdf">http://article.nadiapub.com/IJAST/vol119/11.pdf</a> )	
<b>*Mapping of Course Outcomes for Unit V</b>	CO5	
<b>Unit VI</b>	<b>Code Optimization</b>	<b>07 Hours</b>
	Need for Optimization, local, global and loop optimization, Optimizing transformations, compile time evaluation, common sub-expression elimination, variable propagation, code movement, strength reduction, dead code elimination, DAG based local optimization, Introduction to global data flow analysis, Data flow equations and iterative data flow analysis.	
<b>#Exemplar/Case Studies</b>	Execution of super-scalar processors	
<b>*Mapping of Course Outcomes for Unit VI</b>	CO6	
<b>Learning Resources</b>		

**Text Books:**

1. V Aho, R Sethi, J D Ullman, "Compilers: Principles, Techniques, and Tools", Pearson Edition, ISBN 81-7758-590-8
2. Dick Grune, Bal, Jacobs, Langendoen, " Modern Compiler Design", Wiley, ISBN 81-265-0418-8

**Reference Books:**

1. Anthony J. Dos Reis, "Compiler Construction Using Java", JavaCC and Yacc Wiley, ISBN 978-0-470-94959-7
2. K Muneeswaran, "Compiler Design", Oxford University press, ISBN 0-19-806664-3
3. J R Levin, T Mason, D Brown, "Lex and Yacc", O'Reilly, 2000 ISBN 81-7366-061-X

**eBooks:**

1. **Basics of Compiler Design**

[http://hjemmesider.diku.dk/~torbenm/Basics/basics\\_lulu2.pdf](http://hjemmesider.diku.dk/~torbenm/Basics/basics_lulu2.pdf)

2. **Modern Compiler Design**

<http://160592857366.free.fr/joe/ebooks/ShareData/Modern%20Compiler%20Design%202e.pdf>

**MOOC Courses Links:**

- <https://nptel.ac.in/courses/106105190>

@The CO-PO Mapping Matrix

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



## Savitribai Phule Pune University

### Fourth Year of Computer Engineering (2019 Course)

#### 410246: Laboratory Practice III

<b>Teaching Scheme:</b> Practical: 04 Hours/Week	<b>Credit</b> 02	<b>Examination Scheme:</b> Term work: 50 Marks Practical: 50 Marks
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**Companion Course:** Design and Analysis of Algorithms (410241), Machine Learning(410242), Blockchain Technology(410243)

#### **Course Objectives:**

- Learn effect of data preprocessing on the performance of machine learning algorithms
- Develop in depth understanding for implementation of the regression models.
- Implement and evaluate supervised and unsupervised machine learning algorithms.
- Analyze performance of an algorithm.
- Learn how to implement algorithms that follow algorithm design strategies namely divide and conquer, greedy, dynamic programming, backtracking, branch and bound.
- Understand and explore the working of Blockchain technology and its applications.

#### **Course Outcomes:**

After completion of the course, students will be able to

CO1: Apply preprocessing techniques on datasets.

CO2: Implement and evaluate linear regression and random forest regression models.

CO3: Apply and evaluate classification and clustering techniques.

CO4: Analyze performance of an algorithm.

CO5: Implement an algorithm that follows one of the following algorithm design strategies: divide and conquer, greedy, dynamic programming, backtracking, branch and bound.

CO6: Interpret the basic concepts in Blockchain technology and its applications

#### **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 a 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 a journal 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. Assessment of each Laboratory assignment will assign grade/marks based on parameters, such as timely completion, performance, innovation, efficient codes, punctuality, documentation and neatness.

### **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 each branch beyond the scope of the syllabus.

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

Programming tools recommended: - C++, Java, Python, Solidity, etc.

#### **Virtual Laboratory:**

- <http://cse01-iiith.vlabs.ac.in/>
- <http://vlabs.iitb.ac.in/vlabs-dev/labs/blockchain/labs/index.php>
- [http://vlabs.iitb.ac.in/vlabs-dev/labs/machine\\_learning/labs/index.php](http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php)

### **Suggested List of Laboratory Experiments/Assignments. Assignments from all the Groups (A, B, C) are compulsory.**

### **Course Contents**

#### **Group A: Design and Analysis of Algorithms**

Any 5 assignments and 1 mini project are mandatory.

1. Write a program non-recursive and recursive program to calculate Fibonacci numbers and analyze their time and space complexity.
2. Write a program to implement Huffman Encoding using a greedy strategy.
3. Write a program to solve a fractional Knapsack problem using a greedy method.
4. Write a program to solve a 0-1 Knapsack problem using dynamic programming or branch and bound strategy.
5. Design n-Queens matrix having first Queen placed. Use backtracking to place remaining Queens to generate the final n-queen's matrix.
6. Write a program for analysis of quick sort by using deterministic and randomized variant.

7.	<b>Mini Projects</b> <b>Mini Project</b> - Write a program to implement matrix multiplication. Also implement multithreaded matrix multiplication with either one thread per row or one thread per cell. Analyze and compare their performance.
8.	<b>Mini Project</b> - Implement merge sort and multithreaded merge sort. Compare time required by both the algorithms. Also analyze the performance of each algorithm for the best case and the worst case.
9.	<b>Mini Project</b> - Implement the Naive string matching algorithm and Rabin-Karp algorithm for string matching. Observe difference in working of both the algorithms for the same input.
10	<b>Mini Project</b> - Different exact and approximation algorithms for Travelling-Sales-Person Problem

### Group B: Machine Learning

Any 5 assignments and 1 Mini project are mandatory.

1.	Predict the price of the Uber ride from a given pickup point to the agreed drop-off location. Perform following tasks: 1. Pre-process the dataset. 2. Identify outliers. 3. Check the correlation. 4. Implement linear regression and random forest regression models. 5. Evaluate the models and compare their respective scores like R2, RMSE, etc. Dataset link: <a href="https://www.kaggle.com/datasets/yassher/uber-fares-dataset">https://www.kaggle.com/datasets/yassher/uber-fares-dataset</a>
2.	Classify the email using the binary classification method. Email Spam detection has two states: a) Normal State – Not Spam, b) Abnormal State – Spam. Use K-Nearest Neighbors and Support Vector Machine for classification. Analyze their performance. Dataset link: The emails.csv dataset on the Kaggle <a href="https://www.kaggle.com/datasets/balaka18/email-spam-classification-dataset-csv">https://www.kaggle.com/datasets/balaka18/email-spam-classification-dataset-csv</a>
3.	Given a bank customer, build a neural network-based classifier that can determine whether they will leave or not in the next 6 months. Dataset Description: The case study is from an open-source dataset from Kaggle. The dataset contains 10,000 sample points with 14 distinct features such as CustomerId, CreditScore, Geography, Gender, Age, Tenure, Balance, etc. Link to the Kaggle project: <a href="https://www.kaggle.com/barelydedicated/bank-customer-churn-modeling">https://www.kaggle.com/barelydedicated/bank-customer-churn-modeling</a> Perform following steps: 1. Read the dataset. 2. Distinguish the feature and target set and divide the data set into training and test sets. 3. Normalize the train and test data. 4. Initialize and build the model. Identify the points of improvement and implement the same. 5. Print the accuracy score and confusion matrix (5 points).
4.	Implement Gradient Descent Algorithm to find the local minima of a function. For example, find the local minima of the function $y=(x+3)^2$ starting from the point $x=2$ .

5.	Implement K-Nearest Neighbors algorithm on diabetes.csv dataset. Compute confusion matrix, accuracy, error rate, precision and recall on the given dataset.  Dataset link : <a href="https://www.kaggle.com/datasets/abdallamahgoub/diabetes">https://www.kaggle.com/datasets/abdallamahgoub/diabetes</a>
6.	Implement K-Means clustering/ hierarchical clustering on sales_data_sample.csv dataset. Determine the number of clusters using the elbow method.  Dataset link : <a href="https://www.kaggle.com/datasets/kyanyoga/sample-sales-data">https://www.kaggle.com/datasets/kyanyoga/sample-sales-data</a>
7.	<p style="text-align: center;"><b>Mini Project</b></p> <p><b>Mini Project</b> - Use the following dataset to analyze ups and downs in the market and predict future stock price returns based on Indian Market data from 2000 to 2020. Dataset Link: <a href="https://www.kaggle.com/datasets/sagara9595/stock-data">https://www.kaggle.com/datasets/sagara9595/stock-data</a></p>
8.	<b>Mini Project</b> - Build a machine learning model that predicts the type of people who survived the Titanic shipwreck using passenger data (i.e. name, age, gender, socio-economic class, etc.). Dataset Link: <a href="https://www.kaggle.com/competitions/titanic/data">https://www.kaggle.com/competitions/titanic/data</a>
9.	<b>Mini Project</b> - Develop a application for signature identification by creating your own dataset of your college student
<b>Group C: Blockchain Technology</b>	
Any 5 assignments and 1 Mini project are mandatory.	
1.	Installation of MetaMask and study spending Ether per transaction.
2.	Create your own wallet using Metamask for crypto transactions.
3.	Write a smart contract on a test network, for Bank account of a customer for following operations: <ul style="list-style-type: none"> <li>• Deposit money</li> <li>• Withdraw Money</li> <li>• Show balance</li> </ul>
4.	Write a program in solidity to create Student data. Use the following constructs: <ul style="list-style-type: none"> <li>• Structures</li> <li>• Arrays</li> <li>• Fallback</li> </ul> Deploy this as smart contract on Ethereum and Observe the transaction fee and Gas values.
5.	Write a survey report on types of Blockchains and its real time use cases.
6.	Write a program to create a Business Network using Hyperledger
7.	<p style="text-align: center;"><b>Mini Projects</b></p> <p><b>Mini Project</b> - Develop a Blockchain based application dApp (de-centralized app) for e-voting system.</p>

8.	<b>Mini Project - Develop a Blockchain based application for transparent and genuine charity</b>
9.	<b>Mini Project - Develop a Blockchain based application for health related medical records</b>
10.	<b>Mini Project - Develop a Blockchain based application for mental health</b>

**@The CO-PO Mapping Matrix**

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering(2019Course)**  
**410247:Laboratory Practice IV**

<b>Teaching Scheme</b> <b>Practical: 02 Hours/Week</b>	<b>Credit</b> <b>01</b>	<b>Examination Scheme :</b> <b>Term Work: 50 Marks</b>
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**Companion Course:** Elective III(410244 ), Elective IV(410245)

**Course Objectives:**

- Learn android application development related to pervasive computing
- Understand various multimedia file formats
- Understand various vulnerabilities and use of various tools for assessment of vulnerabilities
- Understand information retrieval process using standard tools available
- Learn GPU programming and implementation of same using open source libraries
- Learn installation and use of open source software testing tools

**Course Outcomes:**

After completion of the course, students will be able to

- CO1: Apply android application development for solving real life problems
- CO2: Design and develop system using various multimedia components.
- CO3: Identify various vulnerabilities and demonstrate using various tools.
- CO4: Apply information retrieval tools for natural language processing
- CO5: Develop an application using open source GPU programming languages
- CO6: Apply software testing tools to perform automated testing

**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 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.

#### **Virtual Laboratory:**

- <https://hci-iitg.vlabs.ac.in/>
- <http://vlabs.iitkgp.ernet.in/se/>
- <https://vlab.amrita.edu/?sub=3&brch=179&sim=1293&cnt=2>

### **410244(A): Pervasive Computing**

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory.

#### **Group 1**

1. Develop an indoor location system to Library guide system where it can direct a user to the bookshelf from a mobile device.
2. Design a pervasive application in which remote computer monitors our health statistics & will determine when one is in trouble & will take appropriate action for rescue.
3. Develop an Android application in which car will use the Internet to find nearby open parking space.
4. Android User Activity Recognition – Still, Walking, Running, Driving etc.
5. Design and build a sensing system using micro-controllers like - Arduino / Raspberry Pi / Intel Galileo to sense the environment around them and act accordingly.
6. Smart Mobile Application with orientation sensing for users to put the phone in meeting / silent mode- OR- outdoor/ loud mode based on the orientation of the device.

#### **Group 2**

7. **PMini project:** Develop Food Ordering System which uses the GPS of an Android-based Smartphone to record and analyze various locations that could give alert to the user, then asking the user to select particular food from given hotel list and place an order.
8. **Mini Project:** Design a mobile sensing platform mounted on a glove that integrates several sensors, such as touch pressure, imaging, inertial measurements, localization and a Radio Frequency Identification (RFID) reader for fruit classification and grading system.
9. **Mini Project:** Sensor-Based Assistive Devices for Visually Impaired People. It should cover following points:
  - Determining obstacles around the user body from the ground to the head;
  - Affording some instructions to the user about the movement surface consists of gaps or textures;
  - Finding items surrounding the obstacles;
  - Providing information about the distance between the user and the obstacle with essential direction instructions.

- 10.** **Mini Project:** Develop a Real time application like a smart home with following requirements: If anyone comes at door the camera module automatically captures his image send it to the email account of user or send notification to the user. Door will open only after user's approval.

## 410244(B): Multimedia Techniques

### Group 1

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory.

1. To study and install open-source multimedia tools and create an application using appropriate tool to design the college webpage
2. To create JPEG Image that demonstrates various features of an Image editing tool.
3. Create or play a sample MIDI format sound file using LMMS / MuseScore / Tuxguitar software tool. Edit the sample file by applying effects like bend, slide, vibrato, and hammer-on/pull-off. Export / Convert final MIDI to WAV file format.
4. Implement transform coding, quantization, and hierarchical coding for the encoder and decoder of three-level Hierarchical JPEG.
5. Create an immersive environment (living room/ battlefield/ tennis court) with only static game objects. 3D game objects can be created using Blender or use available 3D models.
6. Create a web page for a clothing company which contains all the details of that company and atleast five links to other web pages.

### Group 2

#### Group2

7. **Mini Project:** Design and develop a Navigation Assistance System.
8. **Mini Project:** Design and Develop a Traffic Monitoring System.
9. **Mini Project:** Design and develop a Tool for converting image format (e.g. bmp to jpeg )
10. **Mini Project:** Design and develop a Tool for converting audio format (e.g. wav to mp3)

## 410244(C): Cyber Security and Digital Forensics

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory.

### Group 1

1. Write a program for Tracking Emails and Investigating Email Crimes. i.e. Write a program to analyze e-mail header
2. Implement a program to generate and verify CAPTCHA image
3. A person on a nearby road is trying to enter into a WiFi network by trying to crack the Password to use the IP Printer resource; write a program detect such attempt and prohibit the access. Develop the necessary scenario by Using an IEEE 802.11, configure a Wi-Fi adapter and Access Point

4.	Write a computer forensic application program for Recovering permanent Deleted Files and Deleted Partitions
5.	Write a program for Log Capturing and Event Correlation
6.	Configure and demonstrate use of vulnerability assessment tool like Wireshark or SNORT
7.	Study of Honeypot

**Group 2**

8.	<b>Mini-project-</b> Design and develop a tool for digital forensic of images
9.	<b>Mini Project -</b> Design and develop a tool for digital forensic of audio
10.	<b>Mini Project :-</b> Design and develop a tool for digital forensic of video
11.	<b>Mini Project -</b> Design a system for the analysis of cyber crime using various cyber forensic techniques and compare each technique with respect to integrity, confidentiality, availability

**410244(D): Object Oriented Modeling And Design**

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory.

**Group 1**

1.	Draw state model for telephone line, with various activities.
2.	Draw basic class diagrams to identify and describe key concepts like classes, types in your system and their relationships.
3.	Draw one or more Use Case diagrams for capturing and representing requirements of the system. Use case diagrams must include template showing description and steps of the Use Case for various scenarios.
4.	Draw one or more Use Case diagrams for capturing and representing requirements of the system. Use case diagrams must include template showing description and steps of the Use Case for various scenarios.
5.	Draw activity diagrams to display either business flows or like flow charts
6.	Draw component diagrams assuming that you will build your system reusing existing components along with a few new ones
7.	Draw deployment diagrams to model the runtime architecture of your system.

**Group 1**

8.	<b>Mini Project:</b> Draw all UML diagrams for your project work.
9.	<b>Mini Project -</b> Develop a Blockchain based application for health related medical records Draw following UML Diagrams for Bank Management application a. Class Diagram b. Object Diagram c. ER Diagram d. Component Diagram

**410244(E): Digital Signal Processing**

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory

**Group 1**

1.	Develop a program to generate samples of sine, Cosine and exponential signals at specified sampling frequency and signal parameters. (Test the results for different analog frequency (F) and
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	sampling frequency ( $F_s$ ). 23. 4. 5. 6. 7.
2.	Find the output of a system described by given difference equation and initial conditions for given input sequence. (Solution of difference equation) (Obtain the response for different systems by changing Degree of difference equation (N) and coefficients and also for different input sequence $x(n)$ . Observe the response by considering system as FIR and IIR system).
3.	Write a program to plot the magnitude and phase response of a Fourier Transform (FT). (Observe the spectrum for different inputs. Observe the Periodicity).
4.	Find the N point DFT / IDFT of the given sequence $x(n)$ . Plot the magnitude spectrum $ X(K) $ Vs K. (Analyze the output for different N and the same input sequence $x(n)$ . Also observe the periodicity and symmetry property).
5.	Find the N point circular convolution of given two sequences. Test it for Linear convolution. Compute the circular convolution of given two sequences using DFT and IDFT.
6.	Develop a program to plot the magnitude and phase response of a given system ( given: $h(n)$ : impulse response of system S) (Observe the frequency response for different systems. Compare the frequency response of a system (filter) for different length $h(n)$ i.e filter coefficients).

**Group 2:**

7.	<b>Mini-Project:</b> Design and Develop the N-point radix-2 DIT or DIF FFT algorithm to find DFT or IDFT of given sequence $x(n)$ . (Analyze the output for different N. Program should work for any value of N and output should be generated for all intermediate stages.) 8 9.
8.	<b>Mini-Project:</b> Obtain the Fourier transform of different window functions to plot the magnitude and phase spectrums. (Window functions: Rectangular, Triangular, Bartlett, Hamming, Henning, Kaiser. Observe and compare the desirable features of window sequences for different length. Observe the main and side lobes).
9.	<b>Mini-Project:</b> Design an FIR filter from given specifications using windowing method. (Application should work for different types of filter specifications i.e. LPF, HPF, BPF etc and all window sequences. Plot the frequency response for different frequency terms i.e. analog and DT frequency). 10.
10.	<b>Mini-Project:</b> Design of IIR filter for given specifications using Bilinear Transformation. (Generalized code to accept any filter length for a transfer function $H(Z)$ . Application should work for different types of filter specifications that is LPF, HPF, BPF etc. and for different transfer functions of an analog filter).

**410245(A): Information Retrieval**

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory

**Group 1**

1.	Write a program to Compute Similarity between two text documents.
2.	Implement Page Rank Algorithm.
3.	Write a program for Pre-processing of a Text Document: stop word removal.
4.	Write a map-reduce program to count the number of occurrences of each alphabetic character in the given dataset. The count for each letter should be case-insensitive (i.e., include both upper-case and lower-case versions of the letter; Ignore non-alphabetic characters).
5.	Write a program to implement simple web crawler.
6.	Write a program to parse XML text, generate Web graph and compute topic specific page

**Group 2**

7.	Mini project: Develop Document summarization system
8.	Mini Project: Develop Tweet sentiment analysis system
9.	Mini Project: Develop Fake news detection system
10	Mini Project: Develop a Abstractive summarization system

### **410245(B): GPU Programming And Architecture**

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory

#### **Group 1**

1.	Write a program using OpenCL for Heterogeneous computing
2.	Write CUDA programming with some simple things such as dot product, calculation of pi using integration method etc.
3.	Write CUDA programming for matrix transpose and matrix multiplication
4.	Write OpenCL "Hello World" basic program
5.	Develop program using combining abilities of OpenGL and CUDA to accelerate the performance of simple graphics.
6.	Case study on "Review of traditional Computer Architecture"

#### **Group 2:**

7	<b>Mini Project :</b> Huge data computation
8	<b>Mini Project :</b> Visualization to develop project for image processing and then video processing
9	<b>Mini Project :</b> Parallel Algorithm for Searching
10	<b>Mini Project :</b> Parallel Algorithm for Sorting

### **410245(C): Mobile Computing**

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory

#### **Group 1**

1.	To implement a basic function of Code Division Multiple Access (CDMA) to test the orthogonality and autocorrelation of a code to be used for CDMA operation. Write an application based on the above concept.
2.	Implementation of GSM security algorithms (A3/A5/A8)
3.	Write an application that draws basic graphical primitives on the screen.
4.	Develop a native application that uses GPS location information.
5.	Design an android Application for Frame Animation
6.	Create a simulation to show working of 3G Mobile network
7.	Create a simulation to show working of 4G Mobile network

#### **Group 2**

	<p><b>8. Mini Project:</b> Create an application for Bank using spinner, intent</p> <ul style="list-style-type: none"> <li>i) Form 1: Create a new account for customer</li> <li>ii) Form 2: Deposit money in customer account.</li> <li>iii) Link both forms, after completing of first form the user should be directed to second form</li> <li>iv) Provide different menu options</li> </ul>
	<p><b>9. Mini Project:</b> Create the module for collecting cellular mobile network performance parameters using telephony API Manager</p> <ul style="list-style-type: none"> <li>i) Nearest Base Station</li> <li>ii) Signal Strengths</li> <li>iii) SIM Module Details</li> <li>iv) Mobility Management Information</li> </ul>
	<p><b>10 Mini Project:</b> Create the module for payment of fees for College by demonstrating the following methods.</p> <ul style="list-style-type: none"> <li>i) FeesMethod()- for calculation of fees</li> <li>ii) Use customized Toast for successful payment of fees</li> <li>iii) Implement an alarm in case someone misses out on the fee submission deadline</li> <li>iv) Demonstrate the online payment gateway</li> </ul>
	<p><b>11 Mini Project:</b> Create an app to add of a product to SQLite database and make sure to add following features</p> <ul style="list-style-type: none"> <li>i) SMS messaging and email provision ii) Bluetooth options</li> <li>iii) Accessing Web services iv) Asynchronous remote method call</li> <li>v) Use Alert box for user notification</li> </ul>

### **410245(D): Software Testing and Quality Assurance**

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory

#### **Group 1:**

1. Write TEST Scenario for Gmail Login Page
2. Test Scenario for Gmail Login Page
3. Write Test cases in excel sheet for Social Media application or website
4. Create Defect Report for Any application or web application
5. Installation of Selenium grid and selenium Web driver java eclipse (automation tools).
6. Prepare Software requirement specification for any project or problem statement

#### **Group 2:**

7. **Mini Project :**Software Testing and Quality Assurance Mini Project Dynamic website of covid-19 information using HTML, CSS, JAVASCRIPT And PHP, MySQL database used to store user account, comment, and registration form details. Regular Expression testcases for testing purpose
8. **Mini Project :**Create a small application by selecting relevant system environment / platform and programming languages. Narrate concise Test Plan consisting features to be tested and bug taxonomy. Prepare Test Cases inclusive of Test Procedures for identified Test Scenarios.

	Perform selective Black-box and White-box testing covering Unit and Integration test by using suitable Testing tools. Prepare Test Reports based on Test Pass/Fail Criteria and judge the acceptance of application developed
9.	<b>Mini Project :</b> Create a small web-based application by selecting relevant system environment / platform and programming languages. Narrate concise Test Plan consisting features to be tested and bug taxonomy. Narrate scripts in order to perform regression tests. Identify the bugs using Selenium WebDriver and IDE and generate test reports encompassing exploratory testing.

### 410245(E) : Compilers

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory

#### Group 1

1.	Implement a Lexical Analyzer using LEX for a subset of C. Cross check your output with Stanford LEX.
2.	Implement a parser for an expression grammar using YACC and LEX for the subset of C. Cross check your output with Stanford LEX and YACC.
3.	Generate and populate appropriate Symbol Table.
4.	Implement Semantic Analysis Operations like type checking, verification of function parameters, variable declarations and coercions possibly using an Attributed Translation Grammar.
5.	Implement the front end of a compiler that generates the three address code for a simple language.
6.	Implementation of Instruction Scheduling Algorithm.
7.	Implement Local and Global Code Optimizations such as Common Sub-expression Elimination, Copy Propagation, Dead-Code Elimination, Loop and Basic-Block Optimizations. (Optional)
8.	Implement a Lexical Analyzer using LEX for a subset of C. Cross check your output with Stanford LEX.

#### Group 2:

9.	<b>Mini-Project 1:</b> Implement POS tagging for simple sentences written Hindi or any Indian Language
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#### @TheCO-POMappingMatrix

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**410248: Project Work Stage I**

<b>Teaching Scheme:</b> <b>Practical:02Hours/Week</b>	<b>Credit 02</b>	<b>Examination Scheme:</b> <b>Presentation:50Marks</b>
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**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:**

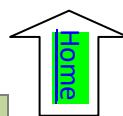
On completion of the course, student will be able to—

- Solve real life problems by applying knowledge.
- Analyze alternative approaches, apply and use most appropriate one for feasible solution.
- Write precise reports and technical documents in a nutshell.
- Participate effectively in multi-disciplinary and heterogeneous teams exhibiting team work
- 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 Engineering (2019 Course)**  
**410249: 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 [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"> <li>• Lectures/ Guest Lectures</li> <li>• Visits (Social/Field) and reports</li> <li>• Demonstrations or presentations</li> </ul> | <ul style="list-style-type: none"> <li>• Surveys</li> <li>• Mini-Project</li> <li>• Hands on experience on focused topic</li> </ul> |
|--|---|

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

- Written Test
- Demonstrations/ Practical Test
- Presentation or Report

**Audit Course 5 Options**

<b>Audit Course Code</b>	<b>Audit Course Title</b>
AC7-I	MOOC- Learn New Skills
AC7-II	Entrepreneurship Development
AC7-III	Botnet of Things
AC7-IV	3D Printing
AC7-V	Industrial Safety and Environment Consciousness



**Savitribai Phule Pune University**  
**Fourth Year of Engineering (2019 Course)**  
**410249: Audit Course 7**  
**AC7 – I: MOOC-learn New Skill**

This course aims to create awareness among the students regarding various courses available under MOOC and learn new skills through these courses.

**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:**

On completion of the course, , students will be able to

CO1: To acquire additional knowledge and skill.

**About Course**

MOOCs (Massive Open Online Courses) provide affordable and flexible way 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 enhances 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 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 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 infrastructural and facilities for the learners.

**References:**

1. <https://swayam.gov.in/>
2. <https://onlinecourses.nptel.ac.in/>
3. <https://www.edx.org>

**Savitribai Phule Pune University, Pune**  
**Fourth Year of Computer Engineering (2019 Course)**  
**410249: Audit Course 7**  
**AC7 – II: Entrepreneurship Development**

This Course aims at instituting Entrepreneurial skills in the students by giving an overview of, who the entrepreneurs are and what competences are needed to become an entrepreneur

**Course Objectives:**

- To introduce the aspects of Entrepreneurship
- To acquaint with legalities in product development
- To understand IPR, Trademarks, Copyright and patenting
- To know the facets of functional plans, Entrepreneurial Finance and Enterprise Management

**Course Outcomes:**

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

- CO1: Understand the legalities in product development
- CO2: Undertake the process of IPR, Trademarks, Copyright and patenting
- CO3: Understand and apply functional plans
- CO4: Manage Entrepreneurial Finance
- CO5: Inculcate managerial skill as an entrepreneur

**Course Contents**

**1. Introduction:** Concept and Definitions, Entrepreneur v/s Intrapreneur; Role of entrepreneurship in economic development; Entrepreneurship process; Factors impacting emergence of entrepreneurship; Managerial versus entrepreneurial Decision Making; Entrepreneur v/s Investors; Entrepreneurial attributes and characteristics; Entrepreneurs versus inventors; Entrepreneurial Culture; Women Entrepreneurs; Social Entrepreneurship; Classification and Types of Entrepreneurs; EDP Programmers; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs.

**2. Creating Entrepreneurial Venture :** Generating Business idea- Sources of Innovation, methods of generating ideas, Creativity and Entrepreneurship; Business planning process; Drawing business plan; Business plan failures; Entrepreneurial leadership – components of entrepreneurial leadership; Entrepreneurial Challenges; Legal issues – forming business entity, considerations and Criteria, requirements for formation of a Private/Public Limited Company, Intellectual Property Protection - Patents Trademarks and Copyrights.

**3. Functional plans:** Marketing plan—for the new venture, environmental analysis, steps in preparing marketing plan, marketing mix, contingency planning; Organizational plan – designing organization structure and Systems; Financial plan – pro forma income statements, Ratio Analysis.

**4. Entrepreneurial Finance:** Debt or equity financing, Sources of Finance - Commercial banks, private placements, venture capital, financial institutions supporting entrepreneurs; Lease Financing; Funding opportunities for Startups in India. 5. Enterprise Management: Managing growth and sustenance- growth norms; Factors for growth; Time management, Negotiations, Joint ventures, Mergers and acquisition

Books:

1. Kumar, Arya, `` Entrepreneurship: Creating and Leading an Entrepreneurial Organization``'', Pearson ISBN-10: 8131765784; ISBN-13: 978-8131765784
2. Hishrich., Peters, ``Entrepreneurship: Starting, Developing and Managing a New Enterprise``'', ISBN 0-256-14147-9
3. Irwin Taneja, ``Entrepreneurship,`` Galgotia Publishers. ISBN: 978-93-84044-82-4
4. Charantimath, Poornima, ``Entrepreneurship Development and Small Business Enterprises,`` Pearson Education, ISBN, 8177582607, 9788177582604.



**Savitribai Phule Pune University, Pune**  
**Fourth Year of Computer Engineering (2019 Course)**  
**410249: Audit Course 7**  
**AC7 – III: Botnet of Things**

This course aims to provide an understanding of the various security attacks and knowledge to recognize and remove common coding errors that lead to vulnerabilities. It gives an outline of the techniques for developing a secure application.

**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:**

On completion of the course, learner will 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**

**2. IRC-Based Bot Networks**

**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

**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. Threat Modeling, Frank Swiderski and Window Snyder, Microsoft Professional, 1 st Edition 2004
3. Gunter Ollmann 2007. The Phishing Guide Understanding and Preventing Phishing Attacks. IBM Internet Security Systems.
4. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978 – 1 – 118 – 47347 - 4, Willy Publications
5. White Papers : <https://www.sans.org/reading-room/whitepapers/malicious/bots-botnet-overview-1299>
6. <https://www-01.ibm.com/marketing/iwm/dre>

Mike Kuniavsky, “Smart Things: Ubiquitous Computing User Experience Design,” Morgan Kaufmann Publishers.

**Savitribai Phule Pune University**  
**Fourth Year of Engineering (2019 Course)**  
**410249: Audit Course 7**  
**AC7 – IV: 3D Printing**

This course aims to provide knowledge of 3D printing devices and explore the business side of 3D printing.

**Course Objectives:**

- To **acquire** basic knowledge of drafting terminology and construction of geometrical figures using drawing instruments, procedure to prepare a drawing sheet as per SP-46:2003
- To **inculcate** skill of technical sketching, multi-view drawings, Lettering, tolerance, and metric construction
- To **impart** practical aspects to generate detailed and assembly views with dimensions, annotations, in 3D Modeling software.
- To **develop** prototype/ end use product for 3D Printing

**Course Outcomes:**

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

**CO1: Understand** the basic knowledge of Shop Floor Safety rules and regulations basics of Machinetools and 3D printing machines

**CO2: Understand** the concept of concept of technical sketching, multi-view drawings, Lettering, tolerance, and metric construction

**CO3: Identify and Distinguish** drafting terminologies and construction of geometrical figures using drawing instruments, procedure to prepare a drawing sheet as per SP-46:2003

**CO4: Describe and Explain** practical aspects to generate detailed and assembly views with dimensions, annotations, in 3D Modeling software.

**CO5: Apply** concepts and **Fabricate** the simple mechanical parts, prototype/ end use product for 3D Printing

**Course Contents**

**1. Getting Started with 3D Printing:** How 3D Printers Fit into Modern Manufacturing, Exploring the Types of 3D Printing, Exploring Applications of 3D Printing.

**2. Outlining 3D Printing Resources:** Identifying Available Materials for 3D Printing, Identifying Available Sources for 3D Printable Objects.

**3. Exploring the Business Side of 3D Printing:** Commoditizing 3D Printing, Understanding 3D Printing's Effect on Traditional lines of Business, Reviewing 3D Printing Research.

**4. Employing Personal 3D printing Devices:** Exploring 3D printed Artwork, Considering Consumer level 3D Printers, Deciding on RepEap of Your Own.

**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
2. 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”



**Savitribai Phule Pune University, Pune  
Fourth Year of Computer Engineering (2019 Course)  
410249: Audit Course 7**

**AC7 – V: Industrial Safety and Environment Consciousness**

This course aims to provide knowledge of industrial safety performance planning and accident prevention.

**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: Develop the plan for Safety performance
- CO2: Demonstrate the action plan for accidents and hazards
- CO3: Apply the safety and security norms in the industry
- CO4: Evaluate 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. Organization Safety**

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. Industrial Pollution**

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.

**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

# SEMESTER VIII



## Savitribai Phule Pune University

### Fourth Year of Computer Engineering (2019 Course)

#### 410250: High Performance Computing

<b>Teaching Scheme:</b> <b>TH: 3 Hours/Week</b>	<b>Credit</b> <b>3</b>	<b>Examination Scheme:</b> <b>In- Sem (TH) : 30</b> <b>End- Sem (TH): 70</b>
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**Prerequisites Courses:** -Microprocessor (210254), Principles of Programming Languages(210255), Computer Networks and Security(310244)

**Companion Course:** Laboratory Practice V(410254)

#### **Course Objectives:**

- To understand different parallel programming models
- To analyze the performance and modeling of parallel programs
- To illustrate the various techniques to parallelize the algorithm
- To implement parallel communication operations.
- To discriminate CUDA Architecture and its components.
- To Understand Scope of Parallel Computing and its search algorithms.

#### **Course Outcomes:**

CO1: **Understand** various Parallel Paradigm

CO2: **Design and Develop** an efficient parallel algorithm to solve given problem

CO3: **Illustrate** data communication operations on various parallel architecture

CO4: **Analyze** and measure performance of modern parallel computing systems

CO5: **Apply** CUDA architecture for parallel programming

CO6: **Analyze** the performance of HPC applications

#### **Course Contents**

<b>Unit I</b>	<b>Introduction to Parallel Computing</b>	<b>07 Hours</b>
<b>Introduction to Parallel Computing:</b> Motivating Parallelism, <b>Modern Processor:</b> Stored-program computer architecture, General-purpose Cache-based Microprocessor architecture. <b>Parallel Programming Platforms:</b> Implicit Parallelism, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines. Levels of parallelism, <b>Models:</b> SIMD, MIMD, SIMT, SPMD, Data Flow Models, Demand-driven Computation, <b>Architectures:</b> N-wide superscalar architectures, multi-core, multi-threaded.		
<b>#Exemplar/Case Studies</b>	Case study: Multi-core System	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1	
<b>Unit II</b>	<b>Parallel Algorithm Design</b>	<b>07 Hours</b>
<b>Principles of Parallel Algorithm Design:</b> Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, <b>Parallel Algorithm Models:</b> Data, Task, Work Pool and Master Slave Model, <b>Complexities:</b> Sequential and Parallel Computational Complexity, Anomalies in Parallel Algorithms.		

#Exemplar/Case Studies	Foster's parallel algorithm design methodology. ( <a href="http://compsci.hunter.cuny.edu/~sweiss/course_materials/csci493.65/lecture_notes/chapter03.pdf">http://compsci.hunter.cuny.edu/~sweiss/course_materials/csci493.65/lecture_notes/chapter03.pdf</a> )	
*Mapping of Course Outcomes for Unit II	CO2	
<b>Unit III</b>	<b>Parallel Communication</b>	<b>07 Hours</b>
<b>Basic Communication:</b> One-to-All Broadcast, All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Collective <b>Communication using MPI:</b> Scatter, Gather, Broadcast, Blocking and non blocking MPI, All-to-All Personalized Communication, Circular Shift, Improving the speed of some communication operations.		
#Exemplar/Case Studies	Monte-Carlo Pi computing using MPI	
*Mapping of Course Outcomes for UnitIII	CO3	
<b>Unit IV</b>	<b>Analytical Modeling of Parallel Programs</b>	<b>07 Hours</b>
Sources of Overhead in Parallel Programs, <b>Performance Measures and Analysis:</b> Amdahl's and Gustafson's Laws, Speedup Factor and Efficiency, Cost and Utilization, Execution Rate and Redundancy, The Effect of Granularity on Performance, Scalability of Parallel Systems, Minimum Execution Time and Minimum Cost, Optimal Execution Time, Asymptotic Analysis of Parallel Programs. <b>Matrix Computation:</b> Matrix-Vector Multiplication, Matrix-Matrix Multiplication.		
#Exemplar/Case Studies	The DAG Model of parallel computation	
*Mapping of Course Outcomes for UnitIV	CO4	
<b>Unit V</b>	<b>CUDA Architecture</b>	<b>07 Hours</b>
<b>Introduction to GPU:</b> Introduction to GPU Architecture overview, Introduction to CUDA C- CUDA programming model, write and launch a CUDA kernel, Handling Errors, CUDA memory model, Manage communication and synchronization, Parallel programming in CUDA- C.		
#Exemplar/Case Studies	GPU applications using SYCL and CUDA on NVIDIA	
*Mapping of Course Outcomes for Unit V	CO5	
<b>Unit VI</b>	<b>High Performance Computing Applications</b>	<b>07 Hours</b>
Scope of Parallel Computing, <b>Parallel Search Algorithms:</b> Depth First Search(DFS), Breadth First Search( BFS), <b>Parallel Sorting:</b> Bubble and Merge, <b>Distributed Computing:</b> Document classification, Frameworks – Kuberbets, GPU Applications, Parallel Computing for AI/ ML		
#Exemplar/Case Studies	Disaster detection and management/ Smart Mobility/Urban planning	
*Mapping of Course Outcomes for Unit VI	CO6	

**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. Seyed H. Roosta, "Parallel Processing and Parallel Algorithms Theory and Computation", Springer-Verlag 2000 ,ISBN 978-1-4612-7048-5 ISBN 978-1-4612-1220-1
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. Kai Hwang,, "Scalable Parallel Computing", McGraw Hill 1998.
2. George S. Almasi and Alan Gottlieb, "Highly Parallel Computing", The Benjamin and Cummings Pub. Co., Inc
3. Jason Sanders, Edward Kandrot, "CUDA by Example", Addison-Wesley, ISBN-13: 978-0-13-138768-3
4. Pacheco, Peter S., "An Introduction to Parallel Programming", Morgan Kaufmann Publishers ISBN 978-0-12-374260-5
5. Rieffel WH. EG, Polak, "Quantum Computing: A gentle introduction", MIT Press, 2011, ISBN 978-0-262-01506-6
6. Ajay D. Kshemkalyani , Mukesh Singhal, "Distributed Computing: Principles, Algorithms, and Systems", Cambridge March 2011, ISBN: 9780521189842

**e Books :**

1. [http://prdrklaina.weebly.com/uploads/5/7/7/3/5773421/introduction\\_to\\_high\\_performance\\_computing\\_for\\_scientists\\_and\\_engineers.pdf](http://prdrklaina.weebly.com/uploads/5/7/7/3/5773421/introduction_to_high_performance_computing_for_scientists_and_engineers.pdf)
2. [https://www.vssut.ac.in/lecture\\_notes/lecture1428643084.pdf](https://www.vssut.ac.in/lecture_notes/lecture1428643084.pdf)

**NPTEL/YouTube video lecture link**

- <https://nptel.ac.in/courses/106108055>
- <https://www.digimat.in/nptel/courses/video/106104120/L01.html>

**@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	-	-	-	1	-	-
CO2	1	2	1	2	1	1	-	-	-	-	-	-
CO3	2	1	-	1	2	1	-	-	1	-	-	1
CO4	1	-	1	1	-	2	1	-	-	-	-	-
CO5	-	1	1	1	1	1	-	-	-	-	-	-
CO6	1	2	1	-	-	1	-	-	-	-	-	1



## Savitribai Phule Pune University

### Fourth Year of Computer Engineering (2019 Course)

#### 410251: Deep Learning

**Teaching Scheme:**

**TH: 03 Hours/Week**

**Credit**

**03**

**Examination Scheme:**

**In-Sem (Paper): 30 Marks**

**End-Sem (Paper): 70 Marks**

**Prerequisite Courses:** Machine Learning (410242)

**Companion Course:** Laboratory Practice V(410254)

#### **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:**

On completion of the course, student will 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 (e.g., with respect to the bias-variance trade-off, overfitting and underfitting, estimation of test error).

**CO3:** To apply the technique of Convolution (CNN) and Recurrent Neural Network (RNN) for implementing Deep Learning models

**CO4:** To implement and apply deep generative models.

**CO5:** Construct and apply on-policy reinforcement learning algorithms

**CO6:** To Understand Reinforcement Learning Process

#### **Course Contents**

##### **Unit I**

##### **Foundations of Deep learning**

**07 Hours**

What is machine learning and deep learning?,Supervised and Unsupervised Learning, bias variance tradeoff,hyper parameters, under/over fitting regularization, Limitations of machine learning, History of deep learning, Advantage and challenges of deep learning. Learning representations from data , Understanding how deep learning works in three figures, Common Architectural Principles of Deep Network, Architecture Design, Applications of Deep learning, Introduction and use of popular industry tools such as TensorFlow,

Keras, PyTorch, Caffe, Shogun.

##### **#Exemplar/Case Studies**

Deep Mind, AlphaGo, Boston Dynamics

##### **\*Mapping of Course Outcomes for Unit I**

CO1

##### **Unit II**

##### **Deep Neural Networks(DNNs)**

**07 Hours**

**Introduction to Neural Networks** :The Biological Neuron, The Perceptron, 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, **Hyperparameters** : Learning Rate, Regularization, Momentum, Sparsity, Deep Feedforward Networks – Example of Ex OR, Hidden Units, cost functions, error backpropagation, Gradient-Based Learning, Implementing Gradient Descent, vanishing and Exploding gradient descent, Sentiment Analysis, Deep Learning with Pytorch, Jupyter, colab.

<b>#Exemplar/CaseStudies</b>	A Case Study for Music Genre Classification
<b>*Mapping of Course Outcomes for Unit II</b>	CO2
<b>Outcomes for Unit II</b>	

<b>Unit III</b>	<b>Convolution Neural Network(CNN)</b>	<b>07 Hours</b>
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		

<b>#Exemplar/Case Studies</b>	AlexNet, VGG
<b>*Mapping of Course Outcomes for Unit III</b>	CO3
<b>Outcomes for Unit III</b>	

<b>Unit IV</b>	<b>Recurrent Neural Network(CNN)</b>	<b>07 Hours</b>
<b>Recurrent and Recursive Nets:</b> 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. <b>Practical Methodology:</b> Performance Metrics, Default Baseline Models, Determining Whether to Gather More Data, Selecting Hyper parameters.		

<b>#Exemplar/Case Studies</b>	Multi-Digit Number Recognition
<b>*Mapping of Course Outcomes for Unit IV</b>	CO3
<b>Outcomes for Unit IV</b>	

<b>Unit V</b>	<b>Deep Generative Models</b>	<b>07 Hours</b>
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		

<b>#Exemplar/Case Studies</b>	GAN for detection of real or fake images
<b>*Mapping of Course Outcomes for Unit V</b>	CO4
<b>Outcomes for Unit V</b>	

<b>Unit VI</b>	<b>Reinforcement Learning</b>	<b>07 Hours</b>
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.		

<b>#Exemplar/Case Studies</b>	Self driving cars, Deep learning for chatbots
<b>*Mapping of Course Outcomes for Unit VI</b>	CO5

### 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”, A textbook
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. by Seth Weidman, “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-Books :**

1. <http://csis.pace.edu/ctappert/cs855-18fall/DeepLearningPractitionersApproach.pdf>
2. [https://www.dkriesel.com/\\_media/science/neuronalenetze-en-zeta2-1col-dkrieselcom.pdf](https://www.dkriesel.com/_media/science/neuronalenetze-en-zeta2-1col-dkrieselcom.pdf)

**MOOC Courses Links:**

- <https://www.my-mooc.com/en/categorie/deep-learning>

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective V**

**410252(A): Natural Language Processing**

Teaching Scheme:	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
TH: 03 Hours/Week		

**Prerequisite Courses:** Discrete Mathematics (210241), Theory of Computation (310242), Data Science and Big Data Analytics (310251)

**Companion Course:** Laboratory Practice VI(410255)

**Course Objectives:**

- To be familiar with fundamental concepts and techniques of natural language processing (NLP)
- To acquire the knowledge of various morphological, syntactic, and semantic NLP tasks
- To develop the various language modeling techniques for NLP
- To use appropriate tools and techniques for processing natural languages
- To comprehend the advance real world applications in NLP domain.
- To Describe Applications of NLP and Machine Translations.

**Course Outcomes:**

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

**CO1:** Describe the fundamental concepts of NLP, challenges and issues in NLP

**CO2:** Analyze Natural languages morphologically, syntactical and semantically OR

Describe the concepts of morphology, syntax, semantics of natural language

**CO3:** Illustrate various language modelling techniques

**CO4:** Integrate the NLP techniques for the information retrieval task

**CO5:** Demonstrate the use of NLP tools and techniques for text-based processing of natural languages

**CO6:** Develop real world NLP applications

**Course Contents**

Unit I	Introduction to Natural Language Processing	07 Hours
<b>Introduction:</b> Natural Language Processing, Why NLP is hard? Programming languages Vs Natural Languages, Are natural languages regular? Finite automata for NLP, Stages of NLP, Challenges and Issues(Open Problems) in NLP		
<b>Basics of text processing:</b>	Tokenization, Stemming, Lemmatization, Part of Speech Tagging	
<b>#Exemplar/Case Studies</b>	Why English is not a regular language: <a href="http://cs.haifa.ac.il/~shuly/teaching/08/nlp/complexity.pdf#page=20">http://cs.haifa.ac.il/~shuly/teaching/08/nlp/complexity.pdf#page=20</a>	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1	
Unit II	Language Syntax and Semantics	07 Hours

**Morphological Analysis:** What is Morphology? Types of Morphemes, Inflectional morphology & Derivational morphology, Morphological parsing with Finite State Transducers (FST)

**Syntactic Analysis:** Syntactic Representations of Natural Language, Parsing Algorithms, Probabilistic context-free grammars, and Statistical parsing

**Semantic Analysis:** Lexical Semantic, Relations among lexemes & their senses – Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Word Sense Disambiguation (WSD), Dictionary

based approach, Latent Semantic Analysis

<b>#Exemplar/CaseStudies</b>	Study of Stanford Parser and POS Tagger <a href="https://nlp.stanford.edu/software/lex-parser.html">https://nlp.stanford.edu/software/lex-parser.html</a> <a href="https://nlp.stanford.edu/software/tagger.html">https://nlp.stanford.edu/software/tagger.html</a>
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<b>*Mapping of Course</b>	CO2
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<b>Outcomes for Unit II</b>	
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<b>Unit III</b>	<b>Language Modelling</b>	<b>07 Hours</b>
Probabilistic language modeling, Markov models, Generative models of language, Log-Liner Models, Graph-based Models		
<b>N-gram models:</b> Simple n-gram models, Estimation parameters and smoothing, Evaluating language models, <b>Word Embeddings/ Vector Semantics:</b> Bag-of-words, TFIDF, word2vec, doc2vec, Contextualized representations (BERT)		
<b>Topic Modelling:</b> Latent Dirichlet Allocation (LDA), Latent Semantic Analysis, Non Negative Matrix Factorization		
<b>#Exemplar/Case Studies</b>	Study of language modelling for Indian languages.	
<b>*Mapping of Course</b>	CO3	
<b>Outcomes for Unit III</b>		

<b>Unit IV</b>	<b>Information Retrieval using NLP</b>	<b>07 Hours</b>
<b>Information Retrieval:</b> Introduction, Vector Space Model		
<b>Named Entity Recognition:</b> NER System Building Process, Evaluating NER System Entity Extraction, Relation Extraction, Reference Resolution, Coreference resolution, Cross Lingual Information Retrieval		
<b>#Exemplar/Case Studies</b>	Natural Language Processing based Information Extraction & Retrieval: <a href="https://www.cdac.in/index.aspx?id=mc_cli_cross_lingual_info">https://www.cdac.in/index.aspx?id=mc_cli_cross_lingual_info</a>	
<b>*Mapping of Course</b>	CO4	
<b>Outcomes for Unit IV</b>		

<b>Unit V</b>	<b>NLP Tools and Techniques</b>	<b>07 Hours</b>
<b>Prominent NLP Libraries:</b> Natural Language Tool Kit (NLTK), spaCy, TextBlob, Gensim etc.		
<b>Linguistic Resources:</b> Lexical Knowledge Networks, WordNets, Indian Language WordNet (IndoWordnet), VerbNets, PropBank, Treebanks, Universal Dependency Treebanks		
Word Sense Disambiguation: Lesk Algorithm Walker's algorithm, WordNets for Word Sense Disambiguation		
<b>#Exemplar/Case Studies</b>	Hindi Wordnet: <a href="https://www.cfilt.iitb.ac.in/wordnet/webhwn/">https://www.cfilt.iitb.ac.in/wordnet/webhwn/</a> Sanskrit WordNet: <a href="https://www.cfilt.iitb.ac.in/wordnet/webswn/">https://www.cfilt.iitb.ac.in/wordnet/webswn/</a> Indic Library: <a href="http://anoopkunchukuttan.github.io/indic_nlp_library/">http://anoopkunchukuttan.github.io/indic_nlp_library/</a>	

<b>*Mapping of Course Outcomes for Unit V</b>	CO5	
<b>Unit VI</b>	<b>Applications of NLP</b>	<b>07 Hours</b>
<b>Machine Translation:</b> Rule based techniques, Statistical Machine Translation (SMT), Cross Lingual Translation		
Sentiment Analysis, Question Answering, Text Entailment, Discourse Processing, Dialog and Conversational Agents, Natural Language Generation		
<b>#Exemplar/Case Studies</b>	Study working of Google Translate Study working of IBM Watson Natural Language Processing	

<b>*Mapping of Course Outcomes for Unit VI</b>	CO6
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### Learning Resources

#### Text Books:

1. Jurafsky, David, and James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing", Computational Linguistics and Speech Recognition, ,PEARSON Publication
2. Manning, Christopher D., and rich Schütze , "Foundations of Statistical Natural Language Processing", Cambridge, MA: MIT Press

#### Reference Books:

1. Steven Bird, Ewan Klein, Edward Loper, "Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit", O'Reilly Publication
2. Dipanjan Sarkar , "Text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from your Data", Apress Publication ISBN: 9781484223871
3. Alexander Clark, Chris Fox, and Shalom Lappin, "The Handbook of Computational Linguistics and Natural Language Processing", Wiley Blackwell Publications
4. Jacob Eisenstein, "Natural Language Processing", MIT Press
5. Jacob Eisenstein, "An Introduction to Information Retrieval", Cambridge University Press

#### e-Books :

1. <https://web.stanford.edu/~jurafsky/slp3/ed3book.pdf>
2. <https://www3.cs.stonybrook.edu/~cse521/L16NLP.pdf>

#### NPTEL Courses links:

- <https://nptel.ac.in/courses/106101007>
- <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
<b>CO1</b>	2	2	1	-	-	-	-	-	-	-	-	-
<b>CO2</b>	3	3	2	2	2	-	-	-	-	-	-	1
<b>CO3</b>	2	3	3	2	2	-	-	-	-	-	-	2
<b>CO4</b>	2	2	3	3	3	-	2	2	-	-	-	3
<b>CO5</b>	2	2	3	3	3	-	-	-	-	-	-	3
<b>CO6</b>	3	3	3	3	3	2	1	1	-	-	-	3



## Savitribai Phule Pune University

### Fourth Year of Computer Engineering (2019 Course)

#### Elective V

#### 410252 (B): Image Processing

<b>Teaching Scheme:</b> TH: 03 Hours/Week	<b>Credit</b> 03	<b>Examination Scheme:</b> <b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>
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**Prerequisites Courses:** Discrete Mathematics (210241)

**Companion Course:** Laboratory Practice VI (410255)

**Course Objectives:**

- To Understand Digital Image Processing Concepts.
- To Study Various Methods for Image Enhancement using Spatial and Frequency Domain.
- To Learn Classification Techniques for Image Segmentation.
- To Understand Image Compression and Object Recognition.
- To Study Various Image Restoration Techniques.
- To Understand various Medical and Satellite Image Processing Applications.

**Course Outcomes:**

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

**CO1:** Apply Relevant Mathematics Required for Digital Image Processing.

**CO2:** Apply Special and Frequency Domain Method for Image Enhancement.

**CO3:** Apply algorithmic approaches for Image segmentation.

**CO4:** Summarize the Concept of Image Compression and Object Recognition.

**CO5:** Explore the Image Restoration Techniques.

**CO6:** Explore the Medical and Satellite Image Processing Applications.

#### Course Contents

<b>Unit I</b>	<b>Introduction to Digital Image Processing</b>	<b>07 Hours</b>
Introduction, Fundamental steps in Digital Image Processing, Components, Elements of visual perception, Image Sensing and Acquisition, Image Sampling and Quantization, Relationships between pixels, different Color Models, Image Types, Image File Formats, Component Labeling algorithm. Introduction to OpenCV tool to Open and Display Images using Python or Eclipse C/C++.		
<b>#Exemplar/Case Studies</b>	Write a program to create a simple image file, save the same in .jpg, .tiff, .bmp format and display it.	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1	
<b>Unit II</b>	<b>Image Enhancement</b>	<b>07 Hours</b>
. Introduction to Image Enhancement and its Importance, Types of Image Enhancement- <b>Spatial Domain Image Enhancement:</b> Intensity Transformations, Contrast Stretching, Histogram Equalization, Correlation and Convolution, Smoothing Filters, Sharpening Filters, Gradient and Laplacian <b>Frequency Domain Image Enhancement:</b> Low Pass filtering in Frequency Domain (Ideal,		

Butterworth, Gaussian), High Pass filter in Frequency Domain (Ideal, Butterworth, Gaussian).

<b>#Exemplar/Case Studies</b>	Write a program for image enhancement using suitable algorithm for Histogram equalization, Local enhancement, Smoothing and Sharpening.
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<b>*Mapping of Course Outcomes for Unit II</b>	CO2
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<b>Unit III</b>	<b>Image Segmentation and Analysis</b>	<b>07 Hours</b>
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Introduction to Image Segmentation and its need. **Classification of Image Segmentation Techniques:** Threshold Based Image Segmentation, Edge Based Segmentation, Edge Detection, Edge Linking, Hough Transform, Watershed Transform, Clustering Techniques, region approach

<b>#Exemplar/Case Studies</b>	Study the different image segmentation techniques for image segmentation
<b>*Mapping of Course Outcomes for Unit III</b>	CO3

<b>Unit IV</b>	<b>Image Compression and Object Recognition</b>	<b>07 Hours</b>
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**Image Compression:** Introduction to Image Compression and its need, Classification of Image Compression Techniques- run-length coding, Shannon Fano coding, Huffman coding, Scalar and vector quantization, Compression Standards-JPEG/MPEG, Video compression.

**Object Recognition:** Introduction, Computer Vision, Tensor Methods in Computer Vision, Classifications Methods and Algorithm, Object Detection and Tracking, Object Recognition.

<b>#Exemplar/Case Studies</b>	Explain image compression and object recognition techniques.
<b>*Mapping of Course Outcomes for Unit IV</b>	CO4

<b>Unit V</b>	<b>Image Restoration and Reconstruction</b>	<b>07 Hours</b>
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Introduction, Model of Image degradation, Noise Models, Classification of image restoration techniques, Blind-deconvolution techniques, Lucy Richardson Filtering, Wiener Filtering

<b>#Exemplar/Case Studies</b>	Explain classification of image restoration techniques.
<b>*Mapping of Course Outcomes for Unit V</b>	CO5

<b>Unit VI</b>	<b>Medical and Satellite Image Processing</b>	<b>07 Hours</b>
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**Medical Image Processing:** Introduction, Medical Image Enhancement, Segmentation, Medical Image Analysis (Images of Brain MRI or Cardiac MRI or Breast Cancer).

**Satellite Image Processing:** Concepts and Foundations of Remote Sensing, GPS, GIS, Elements of Photographic Systems, Basic Principles of Photogrammetry, Multispectral, Thermal, and Hyper spectral Sensing, Earth Resource Satellites Operating in the Optical Spectrum

<b>#Exemplar/Case Studies</b>	Implement application for medical image processing or satellite image processing using OpenCV or Python.
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<b>*Mapping of Course Outcomes for UnitVI</b>	CO6
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**Learning Resources****Text Books:**

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image processing", Pearson Education, Fourth Impression, 2008, ISBN: 978-81-7758-898-9.
2. A. K. Jain, "Fundamentals of Digital Image Processing", PHI, ISBN-978-81- 203- 0929-6.
3. S. Annadurai, R. Shanmugalakshmi, "Fundamentals of Digital Image Processing", Pearson Education, First Edition, 2007, ISBN-8177584790.
4. Boguslaw Cyganek, "Object Detection and Recognition in Digital Images: Theory and Practice", Wiley, First Edition, 2013, ISBN: 978-0-470-97637-1.
5. Ingemar Cox, Matthew Miller, Jeffrey Bloom, Jessica Fridrich, Ton Kalker, "Digital Watermarking and Steganography", Morgan Kaufmann (MK), ISBN: 978-0-12- 372585-1.
6. Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman, "Remote Sensing and Image Interpretation", Wiley, Seventh Edition, 2015, ISBN: 978-1-118-91947-7

**Reference Books :**

1. Isaac Bankman, "Handbook of Medical Imaging", Academic Press, Second Edition, 2008, ISBN: 9780080559148.
2. Jayaraman, Esakkirajan, Veerakumar, "Digital image processing", , Mc Graw Hill, Second reprint- 2010, ISBN(13): 978-0-07-01447-8, ISBN(10):0-07-014479-6.

**e-Books :**

- <https://bookboon.com/en/3d-video-processing-and-transmission-fundamentals-ebook>

**MOOC Courses links :**

- <http://nptel.ac.in/courses/117105079>.

**@The CO-PO Mapping Matrix**

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective V**

**410252(C): Software Defined Networks**

<b>Teaching Scheme:</b> TH: 3 Hours/Week	<b>Credit</b> <b>3</b>	<b>Examination Scheme:</b> In-Sem (Paper):30 Marks End-Sem(Paper):70 Marks
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**Prerequisites Courses:** Computer Networks and Security(310244)

**Companion Course:** Laboratory Practice VI(410255)

**Course Objectives:**

- To learn the fundamentals of software defined networks and understand Differentiation between traditional networks and software defined networks
- To gain conceptual understanding of Software Defined Networking (SDN) and its rolein Data Center.
- To study about the SDN Programming.
- To study industrial deployment use-cases of SDN.
- To study about the various applications of SDN
- To Describe SDN Framework.

**Course Outcomes:**

**On completion of the course, student will be able to—**

CO1: Interpret the need of Software Defined networking solutions.

CO2: Analyze different methodologies for sustainable Software Defined Networkingsolutions.

CO3: Select best practices for design, deploy and troubleshoot of next generation networks.

CO4: Develop programmability of network elements.

CO5: Demonstrate virtualization and SDN Controllers using Open Flow protocol

CO6: Design and develop various applications of SDN

**Course Contents**

<b>Unit I</b>	<b>Introduction</b>	<b>07 Hours</b>
Challenges of traditional networks, History of Software Defined Networking (SDN), Modern Data Center – Traditional Switch Architecture – Why SDN – Evolution of SDN – How SDN Works – Centralized and Distributed Control and Date Planes.		
<b>#Exemplar/Case Studies</b>	Video Streaming <a href="https://kempsdn.com/what-is-sdn-and-use-cases/video-streaming/">https://kempsdn.com/what-is-sdn-and-use-cases/video-streaming/</a>	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1,CO2	
<b>Unit II</b>	<b>OPEN FLOW &amp; SDN CONTROLLERS</b>	<b>07 Hours</b>
Open Flow Overview, The Open Flow Switch, The Open Flow Controller, Open Flow Ports, Message Types, Pipeline Processing, Flow Tables, Matching, Instructions, Action Set and List, Open Flow Protocol, Proactive and Reactive Flow, Timers, Open Flow Limitations, Open Flow Advantages and Disadvantages, Open v Switch Features, Drawbacks of Open SDN, Introduction to SDN controller.		

<b>#Exemplar/Case Studies</b>	Behavior Anomaly Detection in SDN Control Plane: A Case Study of Topology Discovery Attacks <a href="https://www.hindawi.com/journals/wcmc/2020/8898949/">https://www.hindawi.com/journals/wcmc/2020/8898949/</a>	
<b>*Mapping of Course Outcomes for Unit II</b>	CO2,CO3	
<b>Unit III</b>	<b>DATA CENTERS</b>	<b>07 Hours</b>
Data Center Definition, Data Center Demands (Adding, Moving, Deleting Resources, Failure Recovery, Multitenancy, Traffic Engineering and Path Efficiency), Tunneling Technologies for the Data Center, SDN Use Cases in the Data Center, SDN Solutions for the Data Center Network – VLANs – EVPN – VxLAN – NVGRE		
<b>#Exemplar/Case Studies</b>	The World's Second Largest Tier IV Data Center  A Yotta Infrastructure case study  <a href="https://www.missioncriticalmagazine.com/articles/94105-the-worlds-second-largest-tier-iv-data-center">https://www.missioncriticalmagazine.com/articles/94105-the-worlds-second-largest-tier-iv-data-center</a>	
<b>*Mapping of Course Outcomes for Unit III</b>	CO2	
<b>Unit IV</b>	<b>SDN PROGRAMMING</b>	<b>07 Hours</b>
Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs – Introduction of Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications		
<b>#Exemplar/Case Studies</b>	Case study: Ballarat Grammar uses SDN to fight malware <a href="https://www.zdnet.com/home-and-office/networking/case-study-ballarat-grammar-uses-sdn-to-fight-malware/">https://www.zdnet.com/home-and-office/networking/case-study-ballarat-grammar-uses-sdn-to-fight-malware/</a>	
<b>*Mapping of Course Outcomes for Unit IV</b>	CO4	
<b>Unit V</b>	<b>Network Functions Virtualization (NFV)</b>	<b>07 Hours</b>
Definition of NFV, SDN Vs NFV, In-line network functions, Benefits of Network Functions		
Virtualization, Challenges for Network Functions Virtualization, Leading NFV Vendors, Comparison of NFV and NV.		
<b>#Exemplar/Case Studies</b>	NFV deployment case study failure migrate <a href="https://www.dell.com/en-us/blog/nfv-deployment-case-study-failure-migrate/">https://www.dell.com/en-us/blog/nfv-deployment-case-study-failure-migrate/</a>	
<b>*Mapping of Course Outcomes for Unit V</b>	CO5	
<b>Unit VI</b>	<b>SDN Use Cases</b>	<b>07 Hours</b>
Juniper SDN Framework – IETF SDN Framework – Open Daylight Controller – Floodlight Controller – Bandwidth Calendaring – Data Center Orchestration		
<b>#Exemplar/Case Studies</b>	CloudSeeds automate IaaS using SDN and a high-performance network from Juniper.	
<b>*Mapping of Course Outcomes for Unit VI</b>	CO6	

## Learning Resources

**Text Books:**

1. Paul Goransson and Chuck Black, "Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann, 2014, ISBN: 9780124166752, 9780124166844.
2. Siamak Azodolmolky, "Software Defined Networking with Open Flow", Packt Publishing, 2013, ISBN: 9781849698726
3. Thomas D. Nadeau, Ken Gray, "SDN: Software Defined Networks", An Authoritative Review of Network Programmability Technologies, 2013, ISBN : 10:1-4493-4230-2, 9781-4493-4230-2

**Reference Books :**

1. Vivek Tiwari, "SDN and Open Flow for Beginners", Amazon Digital Services, Inc., 2013.
2. Fei Hu, Editor, "Network Innovation through Open Flow and SDN: Principles and Design", CRC Press, 2014.

**e-Books :**

1. <https://ridhanegara.staff.telkomuniversity.ac.id/files/2017/04/Paul-Goransson-and-Chuck-Black-Auth.-Software-Defined-Networks.-A-Comprehensive-Approach.pdf>
2. [https://speetis.fei.tuke.sk/KomunikacnaTechnika1/prednasky/7\\_11\\_2016/kniha\\_sietovanie.pdf](https://speetis.fei.tuke.sk/KomunikacnaTechnika1/prednasky/7_11_2016/kniha_sietovanie.pdf)
3. [https://ridhanegara.staff.telkomuniversity.ac.id/files/2017/04/Thomas-D.-Nadeau-Ken-Gray-SDN-Software-Defined-Networks-O\\_039\\_Reilly-Media-2013.pdf](https://ridhanegara.staff.telkomuniversity.ac.id/files/2017/04/Thomas-D.-Nadeau-Ken-Gray-SDN-Software-Defined-Networks-O_039_Reilly-Media-2013.pdf)

**MOOC Courses Links:**

- <https://nptel.ac.in/courses/108107107>

**@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	-	-	-	-	-
CO2	1	2	2	1	2	-	-	-	-	-	1	-
CO3	2	1	3	1	2	-	-	-	-	-	2	-
CO4	1	2	2	1	2	-	-	-	-	-	2	-
CO5	3	2	2	3	3	-	-	-	-	-	-	-
CO6	1	2	1	3	3	-	-	-	-	-	1	-



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective V**  
**410252(D): Advanced Digital Signal Processing**

<b>Teaching Scheme:</b> <b>TH: 03 Hours/Week</b>	<b>Credit</b> <b>03</b>	<b>Examination Scheme:</b> <b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>
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**Prerequisite Courses:** 410244(A)Digital Signal Processing

**Companion Course:** Laboratory Practice VI(410255)

**Course Objectives:**

- To study the parametric methods for power spectrum estimation.
- To study adaptive filtering techniques and applications of adaptive filtering.
- To learn and understand Multi-rate DSP and applications
- To explore appropriate transforms
- Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech
- Acquire knowledge about different methods used for speech coding and understand various applications of speech processing
- Learn and understand basics of Image Processing and various image filters with its applications

**Course Outcomes:**

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

CO1: Understand and apply different transforms for the design of DT/Digital systems

CO2: Explore the knowledge of adaptive filtering and Multi-rate DSP

CO3: Design DT systems in the field/area of adaptive filtering, spectral estimation and multi-rate DSP

CO4: Explore use of DCT and WT in speech and image processing

CO5: Develop algorithms in the field of speech , image processing and other DSP applications

CO6: Identify Image Processing Techniques

**Course Contents**

<b>Unit I</b>	<b>DFT and Applications</b>	<b>07 Hours</b>
DFT and Applications – Linear filtering, spectral leakage, Spectral resolution and selection of Window Length, Frequency analysis, 2-D DFT, applications in Image and Speech Processing		
<b>#Exemplar/Case Studies</b>	Case Study of Image / Speech Processing Application	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1	
<b>Unit II</b>	<b>Adaptive FIR and IIR filter Design</b>	<b>07 Hours</b>

Adaptive FIR and IIR filter Design – DT Filters, FIR and IIR filters, Adaptive FIR Filter design: Steepest descent and Newton method, LMS method, Applications, Adaptive IIR Filter design: Pade Approximation, Least square design, Applications

<b>#Exemplar/Case Studies</b>	Demonstration of DT filter and FIR filter with suitable application	
<b>*Mapping of Course Outcomes for Unit II</b>	CO2	
<b>Unit III</b>	<b>Multi-rate DSP and applications</b>	<b>07 Hours</b>
Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter Design and Implementation for sampling rate Conversion Multirate Digital Signal Processing Multistage Implementation of Sampling Rate Conversion, Applications of Multirate Signal Processing, Sampling Rate Conversion of Bandpass Signals Linear Prediction And Optimum Linear Filters: Innovations Representation of a Stationary Random Process, Forward and Backward linear prediction, Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters.		
<b>#Exemplar/Case Studies</b>	Implementation for sampling rate Conversion Multi-rate Digital Signal Processing	
<b>*Mapping of Course Outcomes for Unit II</b>	CO3	
<b>Unit IV</b>	<b>Spectral Estimation</b>	<b>07 Hours</b>
Spectral Estimation – Estimation of density spectrum, Nonparametric method, Parametric method, Evaluation ,DCT and WT – DCT and KL transform, STFT, WT, Harr Wavelet and Dubechies Wavelet, Applications of DCT and WT.		
<b>#Exemplar/Case Studies</b>	A spectral estimation case study in frequency-domain by subspace methods	
<b>*Mapping of Course Outcomes for Unit II</b>	CO4	
<b>Unit V</b>	<b>Speech processing</b>	<b>07 Hours</b>
Speech processing - Speech coding: Phase Vocoder, LPC, Sub-band coding, Adaptive Transform Coding, Harmonic Coding, Vector Quantization based Coders. Fundamentals of Speech recognition, Speech segmentation, Text-to-speech conversion, speech enhancement, Speaker Verification, Applications.		
<b>#Exemplar/Case Studies</b>	Investigation of data augmentation techniques for disordered speech recognition	
<b>*Mapping of Course Outcomes for Unit II</b>	CO5	
<b>Unit VI</b>	<b>Image Processing</b>	<b>07 Hours</b>
Image Processing – Image as 2D signal and image enhancement techniques, filter design: low pass, highpass and bandpass for image smoothing and edge detection, Optimum linear filter and order statistic filter, Examples – Wiener and Median filters, Applications		
<b>#Exemplar/Case Studies</b>	Medical image processing for coronavirus (COVID-19) pandemic: A survey	
<b>*Mapping of Course Outcomes for Unit II</b>	CO6	

**Books:****Text:**

1. J. G. Proakis, D. G. Manolakis, " Digital Signal Processing: Principles, Algorithms, and Applications," Prentice Hall, 2007, 4th edition, ISBN: 10: 0131873741
2. Dr. Shaila D. Apate , " Advanced Digital Signal Processing," Wiley Publ., 2013, ISBN-10: 8126541245
3. S. K. Mitra, "Digital Signal Processing : A Computer Based Approach", McGraw HillHigher Education, 2006, 3rd edition, ISBN-10: 0070429537
4. Rabiner and Juang, "Fundamentals of Speech Recognition", Prentice Hall, 1994, ISBN:0-13-015157-2 .
5. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing and Analysis", Pearson Education, 3d Ed., 2007, ISBN: 81-7808-629-8

**References:**

1. Chanda, Muzumdar, "Digital Image Processing and Analysis," Estern Economy Edition,PHI, 2nd Ed., ISBN: 978-81-203-4096-1
2. TarunRawat, "Digital Signal Processing", Oxford University Press, 2015, ISBN-10:0198062281
3. Roberto Crist, "Modern Digital Signal Processing," Thomson Brooks/Cole 2004,ISBN:978-93-80026-55-8.
4. Nelson Morgan and Ben Gold, " Speech and Audio Signal Processing: Processing and Perception Speech and Music", 1999, John Wiley and Sons, ISBN: 0387951547
5. Raghuveer. M. Rao, Ajit S. Bopardikar, "Wavelet Transforms: Introduction to Theory and applications," Pearson Education, Asia, 2000. Dale Grover and John R. (Jack) Deller, "Digital Signal Processing and the Microcontroller", Prentice Hall, ISBN:0-13-754920-2

**eE Books:**

1. Foundations of Signal Processing- <http://fourierandwavelets.org/>
2. <http://www.tka4.org/materials/lib/Articles-Books/Speech%20Recognition/advanced-digital-signal-processing-and-noise-reduction.9780470094945.26435.pdf>
3. [https://www.riverpublishers.com/pdf/ebook/RP\\_E9788792982032.pdf](https://www.riverpublishers.com/pdf/ebook/RP_E9788792982032.pdf)
4. <https://fmipa.umri.ac.id/wp-content/uploads/2016/03/Andreas-Intoniou-Digital-signal-processing.9780071454247.31527.pdf>
5. [http://www-syscom.univ-mlv.fr/~zaidi/teaching/dsp-esipe-oc2/Course-Notes\\_\\_Advanced-DSP.pdf](http://www-syscom.univ-mlv.fr/~zaidi/teaching/dsp-esipe-oc2/Course-Notes__Advanced-DSP.pdf)
6. <https://dl.icdst.org/pdfs/files/25f1b31b38872a4aea5584206534368a.pdf>

**MOOC Courses Links:**

- [https://onlinecourses.nptel.ac.in/noc22\\_ee86/preview](https://onlinecourses.nptel.ac.in/noc22_ee86/preview)

**@The CO-PO Mapping Matrix**

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective V**  
**410252(E): Open Elective I**

<b>Teaching Scheme:</b>	<b>Credit</b>	<b>Examination Scheme:</b>
<b>TH: 03 Hours/Week</b>	<b>03</b>	<b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>

The open elective included, so as to give the student a wide choice of subjects from other Engineering Programs. To inculcate the out of box thinking and to feed the inquisitive minds of the learners the idea of open elective is need of the time. Flexibility is extended with the choice of open elective allows the learner to choose interdisciplinary/exotic/future technology related courses to expand the knowledge horizons. With this idea learner opts for the course without any boundaries to choose the approved by academic council and Board of Studies



## Savitribai Phule Pune University

### Fourth Year of Computer Engineering (2019 Course) Elective VI 410253(A): Pattern Recognition

<b>Teaching Scheme:</b>	<b>Credit</b>	<b>Examination Scheme:</b>
TH: 03 Hours/Week	03	<b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>

**Prerequisite Courses:** Fundamentals of Data Structures(210242), Data Structures and Algorithms(210252)

**Companion Course:** Laboratory Practice VI(410255)

#### **Course Objectives:**

- To learn the basic concept of Pattern recognition
- To study different approaches of pattern recognition
- To learn various pattern classification techniques
- To survey on recent advances and applications in pattern recognition
- To implement Optimal Path Searching techniques.
- To Illustrate Pattern Recognition Techniques.

#### **Course Outcomes:**

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

CO1: Analyze various type of pattern recognition techniques

CO2: Identify and apply various pattern recognition and classification approaches to solve the problems

CO3: Evaluate statistical and structural pattern recognition

CO4: Percept recent advances in pattern recognition confined to various applications

CO5: Implement Bellman's optimality principle and dynamic programming

CO6: Analyze Patterns using Genetic Algorithms & Pattern recognition applications.

#### **Course Contents**

<b>Unit I</b>	<b>Pattern Recognition</b>	<b>07 Hours</b>
Introduction of Pattern Recognition with its application, Pattern Recognition system, Design cycle of pattern recognition, Learning and adaption, Representation of Patterns and classes, Feature Extraction, pattern recognition models/approaches.		
<b>#Exemplar/Case Studies</b>	Evaluation on spatial and temporal variations in water quality by pattern recognition techniques.	
<b>*Mapping of Course Outcomes for Unit I</b>	CO1	
<b>Unit II</b>	<b>Error Estimation &amp; Decision Theory</b>	<b>07 Hours</b>
Introduction, Error estimation methods, various distance measures (Euclidean, Manhattan, cosine, Mahalanobis) and distance based classifier, Feature selection based on statistical hypothesis testing, ROC curve.		
Introduction, Bayesian decision theory-continuous and discrete features, two- category classification, minimum error rate classification, discriminant functions,		

Parametric Techniques:- Maximum Likelihood Estimation, Bayesian Parameter Estimation, Sufficient Statistics; Problems of dimensionality.

Non-Parametric Techniques:-Density estimation, Parzen Window, Metrics and Nearest-Neighbor classification; Fuzzy classification

<b>#Exemplar/Case Studies</b>	Spatial and temporal air quality pattern recognition using environmental techniques
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<b>*Mapping of Course Outcomes for Unit II</b>	CO2
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<b>Unit III</b>	<b>Structural Pattern Recognition</b>	<b>06 Hours</b>
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**Tree Classifiers**-Decision Trees, Random Forests, **Structural Pattern recognition**: Elements of formal grammars ,String generation as pattern description ,Recognition of syntactic description ,Parsing ,Stochastic grammars and applications ,Graph based structural representation, **Stochastic method**: Boltzmann Learning.

<b>#Exemplar/Case Studies</b>	Case Study on spoken word recognition
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<b>*Mapping of Course Outcomes for Unit III</b>	CO3
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<b>Unit IV</b>	<b>Clustering</b>	<b>08 Hours</b>
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Introduction, Hierarchical Clustering, agglomerative clustering algorithm, the single linkage, complete, linkage and average, linkage algorithm. Ward's method ,Partition clustering, , K- means algorithm, clustering algorithms based on graph theory(Minimum spanning tree algorithm),Optimization methods used in clustering: clustering using simulating Annealing.

<b>#Exemplar/Case Studies</b>	Case Study on disease recognition from a list of symptoms
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<b>*Mapping of Course Outcomes for Unit IV</b>	CO3
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<b>Unit V</b>	<b>Template Matching and Unsupervised Learning</b>	<b>07 Hours</b>
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Measures based on Optimal Path Searching techniques: Bellman's optimality principle and dynamic programming, The Edit distance, Dynamic time Warping, Measures based on correlations, Deformable template models

<b>#Exemplar/Case Studies</b>	Pattern recognition in time series database: A case study on financial database.
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<b>*Mapping of Course Outcomes for Unit V</b>	CO4
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<b>Unit VI</b>	<b>Fuzzy Logic and Pattern Recognition</b>	<b>07 Hours</b>
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Fuzzy logic,Fuzzy pattern classifiers, Pattern classification using Genetic Algorithms  
Pattern recognition applications: Application of pattern recognition techniques in object recognition, biometric, facial recognition, IRIS scanner, Finger prints, 3D object recognition

<b>#Exemplar/Case Studies</b>	Study of fingerprint recognition
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### Learning Resources

#### Text Books:

1. R. O. Duda, P. E. Hart, D. G. Stork, "Pattern Classification", 2nd Edition, Wiley-Inter-science, John Wiley & Sons, 2001
2. S. Theodoridis and K. Koutroumbas, "Pattern Recognition", 4<sup>th</sup> Edition, Elsevier, Academic Press, ISBN: 978-1-59749-272-0
3. B.D. Ripley, "Pattern Recognition and Neural Networks", Cambridge University Press. ISBN 0 521 46086 7

#### Reference Books:

1. Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.
2. David G. Stork and Elad Yom-Tov, "Computer Manual in MATLAB to accompany Pattern Classification", Wiley Inter-science, 2004, ISBN-10: 0471429775
3. Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", PHI, ISBN-978-81-203-4091-6
4. eMedia at NPTEL : <http://nptel.ac.in/courses/106108057/33>

#### e-Books :

1. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.320.4607&rep=rep1&type=pdf>
2. [https://cds.cern.ch/record/998831/files/9780387310732\\_TOC.pdf](https://cds.cern.ch/record/998831/files/9780387310732_TOC.pdf)
3. [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)
4. <https://readyforai.com/download/pattern-recognition-and-machine-learning-pdf/>

#### MOOC Courses Links:

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

#### @The CO-PO Mapping Matrix

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

**Savitribai Phule Pune University****Fourth Year of Computer Engineering (2019 Course)****Elective VI****410253( B): Soft Computing**

<b>Teaching Scheme:</b> <b>TH: 03 Hours/Week</b>	<b>Credit</b> <b>03</b>	<b>Examination Scheme:</b> <b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>
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**Prerequisite Courses:** Computer Graphics(210244)**Companion Course:** Laboratory Practice VI(410255)**Course Objectives:**

- To study the various soft computing approaches.
- To understand the soft computing techniques and algorithms for problem solving.
- To be familiar with the various application areas of soft computing.
- To apply the soft computing techniques for developing intelligent systems
- To Explore and solve problems using genetic Algorithms.
- To Understand hybrid systems paradigm and Application Areas of Soft Computing.

**Course Outcomes:**

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

**CO1:** Understand requirement of soft computing and be aware of various soft computing techniques.

**CO2:** Understand Artificial Neural Network and its characteristics and implement ANN algorithms.

**CO3:** Understand and Implement Evolutionary Computing Techniques.

**CO4:** Understand the Fuzzy logic and Implement fuzzy algorithms for solving real life problems.

**CO5:** Apply knowledge of Genetic algorithms for problem solving.

**CO6:** Develop hybrid systems for problem solving.

**Course Contents**

<b>Unit I</b>	<b>Introduction To Soft Computing</b>	<b>07 Hours</b>
<p>Introduction to Soft Computing and Computational Intelligence, Characteristics of Soft computing, Comparison Soft Computing Vs Hard Computing, Requirements of Soft Computing, Soft Computing Techniques – Artificial Neural Network, Fuzzy Logic., Evolutionary computing and Hybrid systems, Applications of Soft Computing</p>		
<b>#Exemplar/Case Studies</b>	<ol style="list-style-type: none"> <li>1. Study of Soft Computing techniques for Waste WaterManagement</li> <li>2. Study of IBM Research Neuro-symbolic AI- a new look for neuromorphic computing</li> </ol>	
<b>*Mapping of Course Outcomes for Unit</b>	CO1	
<b>Unit II</b>	<b>Artificial Neural Network</b>	<b>07 Hours</b>

Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation, functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetero-associative memory, perceptron model, single layer artificial neural network, multilayer perceptron model; back propagation learning methods, effect of learning rule coefficient; back propagation algorithm, factors affecting backpropagation training, applications.

<b>#Exemplar/CaseStudies</b>	Study of Handwriting recognition using ANN.
<b>*Mapping of Course</b>	CO2
<b>Outcomes for Unit II</b>	

<b>Unit III</b>	<b>Evolutionary Computing</b>	<b>07 Hours</b>
Problem Solving as A Search Task, Hill Climbing And Simulated Annealing, Evolutionary Computing, Evolution Strategies, Evolutionary Programming, Genetic Programming, Selected Applications From The Literature: A Brief Description, Scope Of Evolutionary Computing, Introduction to Evolutionary Single-Objective Optimization, Particle Swarm Optimization: Introduction, inspiration, mathematical model, standard and binary PSO. Artificial hummingbird algorithm		
<b>#Exemplar/Case Studies</b>	Study of Engineering application of Artificial hummingbird algorithm	
<b>*Mapping of Course</b>	CO3	
<b>Outcomes for Unit III</b>		

<b>Unit IV</b>	<b>Fuzzy logic</b>	<b>08 Hours</b>
<b>Introduction to Fuzzy Logic, Classical Set, Fuzzy Set</b> - Introduction, Operations on classical sets, properties of classical sets, fuzzy set operations, properties of fuzzy sets, Classical Relation, Fuzzy Relation, <b>Fuzzy Inference process</b> – Membership functions, Fuzzification, Membership value Assignment- Inference, Rank ordering, defuzzification – Weighted Average Method, Mean-Max Membership, Fuzzy Bayesian Decision Making, <b>Developing a Fuzzy Control</b> – System Architecture and Operation of FLC System, FLC System Models, Application of FLC System		
<b>#Exemplar/Case Studies</b>	Study of Object Detection Robot Using Fuzzy Logic Controller	
<b>*Mapping of Course</b>	CO4	
<b>Outcomes for Unit IV</b>		

<b>Unit V</b>	<b>Genetic Algorithm</b>	<b>07 Hours</b>
<b>Introduction To Basic Terminologies in Genetic Algorithm:</b> Individuals, Genes, Fitness, Populations; <b>Simple GA;</b> <b>General Genetic Algorithm;</b> <b>Operators in Genetic Algorithm:</b> Encoding, Selection, Crossover (Recombination), Mutation; <b>Stopping Condition for GA Flow;</b> <b>Constraints in Genetic Algorithms;</b> <b>Problem Solving Using Genetic Algorithm;</b> <b>Holland Classifier System:</b> The Production System, The Bucket Brigade Algorithm and Rule Generation; <b>Advantages and Limitations of Genetic Algorithms;</b> <b>Applications of Genetic Algorithms.</b>		

<b>#Exemplar/Case Studies</b>	Use Genetic Algorithm to design a solution to the Traveling Salesman Problem. <b>Solution:</b> 1. Use Permutation Encoding 2. Define Objective Function. 3. Apply Selection Method 4. Crossover 5. Mutation 6. Repeat Until stopping criteria is met. 7. Stop
<b>*Mapping of Course</b>	CO5
<b>Outcomes for Unit V</b>	

<b>Unit VI</b>	<b>Hybrid System and Application Areas of Soft Computing</b>	<b>07 Hours</b>
Syllabus for Fourth Year of Computer Engineering		

**Hybrid System towards comprehensive Soft Computing:** The hybrid systems paradigm, Hybrid connectionist production systems, Hybrid connectionist logic programming systems, Hybrid fuzzy connectionist production systems, Hybrid systems for speech and language processing, Hybrid systems for decision making.

**Application Areas of Soft Computing:** Fuzzy-filtered Neural Networks-Plasma Spectrum Analysis, Hand-written Numeral Recognition, Fuzzy sets and Genetic Algorithms in Game Playing, Soft Computing for Color Recipe Prediction.

<b>#Exemplar/Case Studies</b>	Study of Hybrid models for disease prediction.
<b>*Mapping of Course Outcomes for Unit VI</b>	CO6

### Learning Resources

#### Text Books:

1. S.N. Sivanandam, “Principles of Soft Computing”, Wiley India- ISBN- 9788126527410
2. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, “Neuro-Fuzzy and Soft Computing A Computational Approach to Learning and Machine Intelligence”, Prentice Hall, ISBN: 978-0132610667
3. L. N. de Castro, “Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications”, 2006, CRC Press, ISBN-13: 978-1584886433 (Chapter 3)
4. S.Rajasekaran, and G. A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms : Synthesis, and Applications”, Prentice Hall of India

#### Reference Books:

##### Reference Books :

1. Nikola K. Kasabov, “Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering”, MIT Press, ISBN:978-0-262-11212-3
2. Seyedali Mirjalili, ‘Evolutionary Algorithms and Neural Networks Theory and Applications, Studies in Computational Intelligence”, Vol 780, Springer, 2019, ISBN 978-3-319-93024-4
3. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Wiley India, ISBN: 978-0-470-74376-8

#### e-Books :

1. <https://kamenpenkov.files.wordpress.com/2016/01/psm-clerc-2006.pdf>
2. <http://www.shahed.ac.ir/stabaii/Files/CompIntelligenceBook.pdf>
3. [https://ctb.iau.ir/Files/%D9%88%D8%A8%20%D8%B3%D8%A7%D8%AA%D8%DB%8C%D8%AF/fuzzy%20logic%20with%20engineering%20application-3rdEdition.pdf](https://ctb.iau.ir/Files/%D9%88%D8%A8%20%D8%B3%D8%A7%D8%DB%8C%D8%AA%20%D8%A7%D8%B3%D8%A7%D8%AA%D8%DB%8C%D8%AF/fuzzy%20logic%20with%20engineering%20application-3rdEdition.pdf)
4. [http://www.soukalfi.edu.sk/01\\_NeuroFuzzyApproach.pdf](http://www.soukalfi.edu.sk/01_NeuroFuzzyApproach.pdf)
5. <https://www.yumpu.com/en/document/read/34361976/evolutionary-computation-a-unified-approach>

#### MOOC Courses Links :

- NPTEL Course – Introduction of Soft Computing, IIT Kharagpur by Prof. Debidas Samanta<https://nptel.ac.in/courses/106105173>
- NPTEL Course – Neural Network and Applications, IIT Kharagpur by Prof. Somnath Sengupta,<https://nptel.ac.in/courses/117105084>
- NPTEL Course – Fuzzy Logic and Neural Networks, IIT Kharagpur by Dilip Kumar Pratihar<https://nptel.ac.in/courses/127105006>

@The CO-PO Mapping Matrix

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective VI**  
**410253(C): Business Intelligence**

<b>Teaching Scheme:</b> TH: 03 <b>Hours/Week</b>	<b>Credit</b> <b>03</b>	<b>Examination Scheme:</b> <b>In-Sem (Paper) : 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>
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**Prerequisites Courses:** Database Management System(310241), Data Science & Big data Analytics(310251), Machine Learning (410242)

**Companion Course:** Laboratory Practice VI(410256)

**Course Objectives:**

- To introduce the concepts and components of Business Intelligence (BI)
- To evaluate the technologies that make up BI (data warehousing, OLAP)
- To identify the technological architecture of BI systems.
- To explain different data preprocessing techniques
- To identify machine learning model as per business need
- To understand the BI applications in marketing, logistics, finance and telecommunication sector

**Course Outcomes:** On completion of this course, the students will be able to

CO1: Differentiate the concepts of Decision Support System & Business Intelligence

CO2: Use Data Warehouse & Business Architecture to design a BI system.

CO3: Build graphical reports

CO4: Apply different data preprocessing techniques on dataset

CO5: Implement machine learning algorithms as per business needs

CO6: Identify role of BI in marketing, logistics, and finance and telecommunication sector

**Course Contents**

<b>Unit I</b>	<b>Introduction to Decision support systems and Business intelligence</b>	<b>07 Hours</b>
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**Decision support systems:** Definition of system, representation of the decision-making process, evolution of information systems, Decision Support System, Development of a decision support system, the four stages of Simon's decision-making process, and common strategies and approaches of decision makers

**Business Intelligence:** BI, its components & architecture, previewing the future of BI, crafting a better experience for all business users, End user assumptions, setting up data for BI, data, information and knowledge, The role of mathematical models, Business intelligence architectures, Ethics and business intelligence

<b>#Exemplar/Case Studies</b>	Decision support system in business intelligence: <a href="https://www.riverlogic.com/blog/five-decision-support-system-examples">https://www.riverlogic.com/blog/five-decision-support-system-examples</a>
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<b>*Mapping of Course Outcomes for Unit I</b>	CO1
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<b>Unit II</b>	<b>The Architecture of DW and BI</b>	<b>07 Hours</b>
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BI and DW architectures and its types - Relation between BI and DW - OLAP (Online analytical processing) definitions - Different OLAP Architectures-Data Models-Tools in Business Intelligence-Role of DSS, EIS, MIS and digital Dash boards – Need for Business Intelligence

Difference between OLAP and OLTP - Dimensional analysis - What are cubes? Drill-down and roll-up - slice and dice or rotation - OLAP models - ROLAP versus MOLAP - defining schemas: Stars, snowflakes and fact constellations.

#Exemplar/Case Studies	A case study on Retail Industry : <a href="https://www.diva-portal.org/smash/get/diva2:831050/FULLTEXT01.pdf">https://www.diva-portal.org/smash/get/diva2:831050/FULLTEXT01.pdf</a>
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*Mapping of Course Outcomes for Unit II	CO2
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Unit III	Reporting Authoring	07 Hours
Building reports with relational vs Multidimensional data models; Types of Reports – List, crosstabs, Statistics, Chart, map, financial etc; Data Grouping & Sorting, Filtering Reports, Adding Calculations to Reports, Conditional formatting, Adding Summary Lines to Reports. Drill up, drill- down, drill-through capabilities. Run or schedule report, different output forms – PDF, excel, csv, xml etc.		

#Exemplar/Case Studies	Power BI Case Study – How the tool reduced hassles of Heathrow & Edsby: <a href="https://data-flair.training/blogs/power-bi-case-study/">https://data-flair.training/blogs/power-bi-case-study/</a>
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*Mapping of Course Outcomes for Unit III	CO3
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Unit IV	Data preparation	07 Hours
<b>Data validation:</b> Incomplete data , Data affected by noise . <b>Data transformation:</b> Standardization , Feature extraction. <b>Data reduction :</b> Sampling, Feature selection, Principal component analysis, Data discretization . <b>Data exploration :</b> <b>1.Univariate analysis</b> :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 <b>2.Bivariate analysis:</b> Graphical analysis , Measures of correlation for numerical attributes , Contingency tables for categorical attributes, <b>3.Multivariate analysis:</b> Graphical analysis , Measures of correlation for numerical attributes		

#Exemplar/Case Studies	Case study on Data preparation phase of BI system <a href="https://blog.panoply.io/load-and-transform-how-to-prepare-your-data-for-business-intelligence">https://blog.panoply.io/load-and-transform-how-to-prepare-your-data-for-business-intelligence</a>
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*Mapping of Course Outcomes for Unit IV	CO4
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Unit V	Impact of Machine learning in Business Intelligence Process	07 Hours
<b>Classification:</b> Classification problems, Evaluation of classification models, Bayesian methods, Logistic regression. <b>Clustering:</b> Clustering methods, Partition methods, Hierarchical methods, Evaluation of clustering models. <b>Association Rule:</b> Structure of Association Rule, Apriori Algorithm		

#Exemplar/Case Studies	Business applications for comparing the performance of a stock over a period of time <a href="https://cleartax.in/s/stock-market-analysis">https://cleartax.in/s/stock-market-analysis</a>
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*Mapping of Course Outcomes for Unit V	CO5
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Unit VI	BI Applications	07 Hours
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Tools for Business Intelligence, Role of analytical tools in BI, Case study of Analytical Tools: WEKA, KNIME, Rapid Miner, R;

Data analytics, Business analytics, ERP and Business Intelligence, BI and operation management, BI in inventory management system, BI and human resource management, BI Applications in CRM, BI Applications in Marketing, BI Applications in Logistics and Production, Role of BI in Finance, BI Applications in Banking, BI Applications in Telecommunications, BI in salesforce management

#Exemplar/Case Studies	Logistics planning in the food industry <a href="https://www.foodlogistics.com/case-studies">https://www.foodlogistics.com/case-studies</a> <a href="https://www.barrettdistribution.com/food-distribution-case-study">https://www.barrettdistribution.com/food-distribution-case-study</a>
*Mapping of Course Outcomes for Unit VI	CO6

### Learning Resources

#### Text Books:

1. Fundamental of Business Intelligence, Grossmann W, Rinderle-Ma, Springer,2015
2. R. Sharda, D. Delen, & E. Turban, Business Intelligence and Analytics. Systems for Decision Support, 10th Edition. Pearson/Prentice Hall, 2015

#### Reference Books :

1. Paulraj Ponnian, “Data Warehousing Fundamentals”, John Willey.
2. Introduction to business Intelligence and data warehousing, IBM, PHI
3. Business Intelligence: Data Mining and Optimization for Decision Making, Carlo Vercellis, 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 Warehousing, Pearson Education,2012, ISBN-13 978 8131786826

#### e-Books :

1. [https://www.knime.com/sites/default/files/inline-images/KNIME\\_quickstart.pdf](https://www.knime.com/sites/default/files/inline-images/KNIME_quickstart.pdf)
2. [www.cs.ccsu.edu/~markov/weka-tutorial.pdf](http://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](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>

#### NPTEL/YouTube video lecture links:

- Business Analytics for management decision : <https://nptel.ac.in/courses/110105089>
- Business analytics and data mining modeling using R : <https://nptel.ac.in/courses/110107092>
- 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	1	2	1	1	2	-	-	-	-	-	-	-
CO2	1	1	1	1	1	-	-	-	-	-	-	-
CO3	1	2	1	1	1	-	-	-	-	-	-	-
CO4	2	2	2	1	1	-	-	-	-	-	-	-
CO5	2	2	2	2	1	-	-	-	-	-	-	-
CO6	-	1	-	1	1	-	-	-	-	-	-	-



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective VI**

**410253(D): Quantum Computing**

**Teaching Scheme:**

**TH: 03 Hours/Week**

**Credit**

**03**

**Examination Scheme:**

**In-Sem (Paper): 30 Marks**

**End-Sem (Paper): 70 Marks**

**Prerequisite Courses:** Data Structures and Algorithms(210243), Data Science and Big Data Analytics (310251)

**Companion Course:** Laboratory Practice IV(410247)

**Course Objectives:**

- To provide introduction and necessary expertise to the learner in the upcoming discipline of Quantum Computing and Machine Learning.
- To enable the students to learn Quantum Computing and Quantum Machine Learning in practical-oriented learning sessions so that he/she can independently use existing open-source Quantum Computing Hardware and Software Frameworks
- To teach the students to develop hybrid solutions by applying Quantum Machine Learning to potential business application areas.
- To study Quantum Information Theory and Quantum Computing Programming Model of Computation.
- To study Quantum Algorithms and apply these to develop hybrid solutions .
- To study Quantum Concepts necessary for understanding the Quantum Computing Paradigm and compare the available hardware and software infrastructure and frameworks made available open source by major players in the Industry and Academia.

**Course Outcomes:**

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

CO1: To understand the concepts of Quantum Computing

CO2: To understand and get exposure to mathematical foundation and quantum mechanics

CO3: To understand and implement building blocks of Quantum circuits

CO4: To understand quantum information, its processing and Simulation tools

CO5: To understand basic signal processing algorithms FT, DFT and FFT

CO6 : To study and solve examples of Quantum Fourier Transforms and their applications

**Course Contents**

Unit I	Introduction to Quantum Computing	07 Hours
Fundamental Concepts of Quantum computing: Introduction and Overview, Global Perspective, Quantum Bits, Quantum Computation, Quantum Algorithms, Quantum information and Quantum information processing,		
<u>*Mapping of CourseOutcomes for Unit I</u>	CO1	
Unit II	Mathematical foundation of Quantum Computing	07 Hours
Quantum Mechanics: Linear Algebra and Quantum mechanics, Postulates of Quantum mechanics, state space, evolution, Quantum measurement, distinguishing quantum states, projective measurements, POVM measurements, Phase, Composite systems, Global view and applications, Density operator		

<b>*Mapping of Course Outcomes for Unit II</b>	CO2	
<b>Unit III</b>	<b>Building Blocks for Quantum Program</b>	<b>07 Hours</b>
Quantum Computations: Quantum circuits, Quantum algorithms and qubit operations, Controlled operations, Principal deferred and Principal implicit Measurements, Universal Quantum Gates, Two level unitary gates, single qubit and CNOT , discrete set of universal operations, Quantum computational complexity		
<b>*Mapping of CourseOutcomes for Unit III</b>	CO3	
<b>Unit IV</b>	<b>Quantum Simulation Algorithms and Fourier Transform</b>	<b>07 Hours</b>
Simulation of Quantum Systems, Simulation in action,exponential complexity growth of quantum systems,, Quantum simulation algorithm, examples of quantum simulations, perspectives of quantum simulation, Understanding Basics of Fourier transform, Discrete Fourier Transform, Fast Fourier Transform, Definitions, mathematical representations of FT, DFT and FFT		
<b>*Mapping of CourseOutcomes for Unit IV</b>	CO3,CO4	
<b>Unit V</b>	<b>Quantum Fourier Transform and Applications</b>	<b>07 Hours</b>
Quantum Fourier Transform , Phase estimation performance and requirements, order finding application, factoring application, General applications of Quantum Fourier transform, period finding, discrete algorithms, Other Quantum Algorithms.		
<b>*Mapping of CourseOutcomes for Unit V</b>	CO5	
<b>Unit VI</b>	<b>Quantum Machine Learning</b>	<b>07 Hours</b>
Quantum Machine Learning and Quantum AI, Quantum Neural Networks, Quantum Natural Language Understanding, Quantum Cryptography, Application Domains for Quantum Machine Learning: Chemistry/Material Science, Space Tech, Finance related Optimization Problems, Swarm Robotics, Cyber security		
<b>*Mapping of CourseOutcomes for Unit VI</b>	CO6	
<b>Learning Resources</b>		
<b>Text Books:</b>		
<ol style="list-style-type: none"> <li>1. Michael A. Nielsen, “Quantum Computation and Quantum Information”, Cambridge University</li> <li>2. Wittek, “Quantum Machine Learning (What Quantum Computing Means to Data Mining)”, Peter University of Boras, Sweden - Elsevier Publications</li> <li>3. Andreas Winchert, “Principles of Quantum Artificial Intelligence”, Instituto Superior Técnico - Universidade de Lisboa, Portugal - World Scientific Publishing, British Library Cataloguing-in-Publication Data</li> </ol>		

**Reference Books:**

1. Press Stephen Kan, "Metrics and Models in Software Quality Engineering", Pearson, ISBN-10: 0133988082; ISBN-13: 978-0133988086
2. Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University Press
3. David McMahon, "Quantum Computing Explained", Wiley
4. Microsoft Quantum Development Kit <https://www.microsoft.com/enus/quantum/development-kit>
5. Amazon Braket Documentation on AWS: <https://aws.amazon.com/braket/> 7 D-Wave Systems Documentation: <https://docs.dwavesys.com/docs/latest/index.html>

**e-Books :**

- 1. <http://mmrc.amss.cas.cn/tlb/201702/W020170224608149940643.pdf>
- 2. <http://mmrc.amss.cas.cn/tlb/201702/W020170224608150244118.pdf>

**MOOC Courses Links:**

- [https://onlinecourses.nptel.ac.in/noc21\\_cs103/preview](https://onlinecourses.nptel.ac.in/noc21_cs103/preview)
- <https://www.coursera.org/learn/introduction-to-quantum-information>

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



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**Elective VI**  
**410253(E): Open Elective II**

<b>Teaching Scheme:</b> TH: 03Hours/Week	<b>Credit</b> 03	<b>Examination Scheme:</b> <b>In-Sem (Paper): 30 Marks</b> <b>End-Sem (Paper): 70 Marks</b>
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**Companion Course:** Laboratory Practice VI (410255)

The open elective included, to give the student a wide choice of subjects from other Engineering Programs. To inculcate the out of box thinking and to feed the inquisitive minds of the learners the idea of open elective is need of the time.

Flexibility is extended with the choice of open elective allows the learner to choose interdisciplinary/exotic/future technology related courses to expand the knowledge horizons.

With this idea learner opts for the course without any boundaries to choose the approved by academic council and Board of Studies.



## Savitribai Phule Pune University

### Fourth Year of Computer Engineering (2019 Course)

#### 410255: Laboratory Practice V

<b>Teaching Scheme:</b> <b>Practical: 2 Hours/Week</b>	<b>Credit</b> <b>01</b>	<b>Examination Scheme</b> <b>Term Work: 50 Marks</b> <b>Practical: 50 Marks</b>
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**Companion Course:** High Performance Computing (410250), Deep Learning(410251)

#### **Course Objectives:**

- To understand and implement searching and sorting algorithms.
- To learn the fundamentals of GPU Computing in the CUDA environment.
- To illustrate the concepts of Artificial Intelligence/Machine Learning (AI/ML).
- To understand Hardware acceleration.
- To implement different deep learning models.

#### **Course Outcomes:**

**CO1: Analyze and measure** performance of sequential and parallel algorithms.

**CO2: Design and Implement** solutions for multicore/Distributed/parallel environment.

**CO3: Identify and apply** the suitable algorithms to solve AI/ML problems.

**CO4: Apply** the technique of Deep Neural network for implementing Linear regression and classification.

**CO5: Apply** the technique of Convolution (CNN) for implementing Deep Learning models.

**CO6: Design and develop** Recurrent Neural Network (RNN) for prediction.

#### **Guidelines for Instructor's Manual**

Laboratory Practice V is for practical hands on for core courses High Performance Computing and Data Learning. The instructor's manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/guidelines, references among others.

#### **Guidelines for Student's Laboratory Journal**

The laboratory assignments are to be submitted by student in the form of journal. Journal may

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/Database design, test cases, conclusion/analysis). Program codes with sample output of all performed assignments are to be submitted as softcopy.

### **Guidelines for Laboratory /Term Work Assessment**

Continuous assessment of laboratory work is to be done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness reserving weightage for successful mini-project completion and related documentation.

### **Guidelines for Practical Examination**

- Both internal and external examiners should jointly frame suitable problem statements for practical examination based on the term work completed.
- 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.
- 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 boost to the student's academics.

### **Guidelines for Laboratory Conduction**

- List of recommended programming assignments and sample mini-projects is provided for reference.
- Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses.
- Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
- Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
- Mini-project can be completed in group of 2 to 3 students.

- Software Engineering approach with proper documentation is to be strictly followed.
- Use of open source software is to be encouraged.
- Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.

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

Programming Languages: Object Oriented Languages

C++/JAVA/PYTHON/R

Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, Backend :

MongoDB/MYSQL/Oracle, Database Connectivity : ODBC/JDBC

### **Suggested List of Laboratory Experiments/Assignments**

#### **410250 : High Performance Computing**

Any 4 Assignments and 1 Mini Project are Mandatory

#### **Group 1**

1.	Design and implement Parallel Breadth First Search and Depth First Search based on existing algorithms using OpenMP. Use a Tree or an undirected graph for BFS and DFS .
2.	Write a program to implement Parallel Bubble Sort and Merge sort using OpenMP. Use existing algorithms and measure the performance of sequential and parallel algorithms.
3.	Implement Min, Max, Sum and Average operations using Parallel Reduction.
4.	Write a CUDA Program for : <ol style="list-style-type: none"> <li>1. Addition of two large vectors</li> <li>2. Matrix Multiplication using CUDA C</li> </ol>
5.	Implement HPC application for AI/ML domain.

#### **Group 2**

6.	Mini Project: Evaluate performance enhancement of parallel Quicksort Algorithm using MPI
7.	Mini Project: Implement Huffman Encoding on GPU
8.	Mini Project: Implement Parallelization of Database Query optimization
9.	Mini Project: Implement Non-Serial Polyadic Dynamic Programming with GPU Parallelization

#### **410251 : Deep Learning**

Any 3 Assignments and 1 Mini Project are Mandatory

#### **Group 1**

1.	<b>Linear regression by using Deep Neural network:</b> Implement Boston housing price prediction problem by Linear regression using Deep Neural network. Use Boston House price prediction dataset.
2.	<b>Classification using Deep neural network</b> (Any One from the following) <ol style="list-style-type: none"> <li>Multiclass classification using Deep Neural Networks: Example: Use the OCR letter recognition dataset <a href="https://archive.ics.uci.edu/ml/datasets/letter+recognition">https://archive.ics.uci.edu/ml/datasets/letter+recognition</a></li> <li>Binary classification using Deep Neural Networks Example: Classify movie reviews into positive" reviews and "negative" reviews, just based on the text content of the reviews. Use IMDB dataset</li> </ol>
3.	<b>Convolutional neural network (CNN)</b> (Any One from the following) <ul style="list-style-type: none"> <li>Use any dataset of plant disease and design a plant disease detection system using CNN.</li> <li>Use MNIST Fashion Dataset and create a classifier to classify fashion clothing into categories.</li> </ul>
4.	<b>Recurrent neural network (RNN)</b> Use the Google stock prices dataset and design a time series analysis and prediction system using RNN.

**Group 2**

5.	<b>Mini Project:</b> Human Face Recognition
6.	<b>Mini Project:</b> Gender and Age Detection: predict if a person is a male or female and also their age
7.	<b>Mini Project:</b> Colorizing Old B&W Images: color old black and white images to colorful images

**@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	1	1	1	1	-	-	-	-	-	-
CO4	3	3	3	-	3	-	-	-	-	-	-	-
CO5	3	3	3	3	3	-	-	-	-	-	-	-
CO6	3	3	3	3	3	-	-	-	-	-	-	-
CO7	3	3	3	3	3		-	-	-	-	-	-



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**410256: Laboratory Practice VI**

<b>Teaching Scheme:</b> <b>Practical: 2 Hours/Week</b>	<b>Credit</b> <b>01</b>	<b>Examination Scheme :</b> <b>Term Work: 50 Marks</b>
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**Companion Course:** Elective V (410252), Elective VI( 410253)

**Course Objectives:**

- To understand the fundamental concepts and techniques of natural language processing (NLP)
- To understand Digital Image Processing Concepts
- To learn the fundamentals of software defined networks
- Explore the knowledge of adaptive filtering and Multi-rate DSP
- To be familiar with the various application areas of soft computing.
- To introduce the concepts and components of Business Intelligence (BI)
- To study Quantum Algorithms and apply these to develop hybrid solutions

**Course Outcomes:**

On completion of this course, the students will be able to

CO1: Apply basic principles of elective subjects to problem solving and modeling.

CO2: Use tools and techniques in the area of software development to build mini projects

CO3: Design and develop applications on subjects of their choice.

CO4: Generate and manage deployment, administration & security.

**Guidelines for Instructor's Manual**

List of recommended programming assignments and sample mini-projects is provided for reference. Referring to these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses. Preferably there should be multiple sets of assignments/mini-project and distributed among batches of students. Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects. Mini-project can be completed in group of 2 to 3 students. Software Engineering approach with proper documentation is to be strictly followed. Use of open source software is to be encouraged. Instructor may also set one assignment or mini-project that is suitable to the respective course beyond the scope of syllabus.

**Operating System recommended:** - 64-bit Open source Linux or its derivative **Programming Languages:** C++/JAVA/PYTHON/R

**Programming tools recommended:** Front End: Java/Perl/PHP/Python/Ruby/.net, **Backend:** MongoDB/MYSQL/Oracle, Database Connectivity: ODBC/JDBC, **Additional Tools:** Octave, Matlab, WEKA,powerBI

### Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by students in the form of a journal. Journal may 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/Database design, test cases, 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 digital storage media/DVD containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

### Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work is to be done based on overall performance and lab Home Faculty of Engineering Savitribai Phule Pune University

Syllabus for Fourth Year of Computer Engineering assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness reserving weightage for successful mini-project completion and related documentation.

### Guidelines for Practical Examination

It is recommended to conduct examination based on Mini-Project(s) Demonstration and related skill learned. Team of 2 to 3 students may work on mini-project. During the assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation and software engineering approach followed. The supplementary and relevant questions may be asked at the time of evaluation to test the student's for advanced learning, understanding, effective and efficient implementation and demonstration skills. 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.

### Guidelines for Laboratory Conduction

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

**Recommended / Sample set of assignments and mini projects for reference for four courses offered for Elective III and for four courses offered for Elective IV. Respective Student has to complete laboratory work for elective III and IV that he/she has opted.**

### 410252(A): Natural Language Processing

Any 5 Assignments and 1 Mini Project are mandatory

**Group 1**

1.	Perform tokenization (Whitespace, Punctuation-based, Treebank, Tweet, MWE) using NLTK library. Use porter stemmer and snowball stemmer for stemming. Use any technique for lemmatization. <b>Input / Dataset –use any sample sentence</b>
2	Perform bag-of-words approach (count occurrence, normalized count occurrence), TF-IDF on data. Create embeddings using Word2Vec. <b>Dataset to be used:</b> <a href="https://www.kaggle.com/datasets/CooperUnion/cardataset">https://www.kaggle.com/datasets/CooperUnion/cardataset</a>
3	Perform text cleaning, perform lemmatization (any method), remove stop words (any method), label encoding. Create representations using TF-IDF. Save outputs. <b>Dataset:</b> <a href="https://github.com/PICT-NLP/BE-NLP-Elective/blob/main/3-Preprocessing/News_dataset.pickle">https://github.com/PICT-NLP/BE-NLP-Elective/blob/main/3-Preprocessing/News_dataset.pickle</a>
4	Create a transformer from scratch using the Pytorch library
5	Morphology is the study of the way words are built up from smaller meaning bearing units. Study and understand the concepts of morphology by the use of add delete table

**Group 2**

6	<b>Mini Project</b> (Fine tune transformers on your preferred task) Finetune a pretrained transformer for any of the following tasks on any relevant dataset of your choice: <ul style="list-style-type: none"> <li>• Neural Machine Translation</li> <li>• Classification</li> <li>• Summarization</li> </ul>
7	<b>Mini Project -</b> POS Taggers For Indian Languages
8	<b>Mini Project -</b> Feature Extraction using seven moment variants
9	<b>Mini Project -</b> Feature Extraction using Zernike Moments

Virual Lab:<https://nlp-iiith.vlabs.ac.in/>

410252(B) Image Processing

Any 5 Assignments and 1 Mini Project are mandatory

Group 1

Programming language: Python/C/C++ using OpenCV

1.	Consider any image with size 1024*1024. Modify the image to the sizes 512*512, 256*256, 128*128, 64*64 and 32*32 using subsampling technique. Create the original image from all the above subsampled images using resampling technique. Read any image. Display the histogram, Equalized histogram, and image with equalized histogram
2	Consider any image with size 1024*1024. Modify the image to the sizes 512*512, 256*256, 128*128, 64*64 and 32*32 using subsampling technique. Create the original image from all the above subsampled images using resampling technique.
3	Read any image. Display the histogram, Equalized histogram, and image with equalized histogram
4	Read any image. Display the outputs of contrast stretching, intensity level slicing
5	Compare the results of any three edge detection algorithms on the same image dataset and do the analysis of the result.
6	Compare the result of any two image segmentation algorithm on the same image data set
7	Write a program for image compression using any three compression techniques and compare the results.

**Group 2**

8	<b>Mini project:</b> Implement visual surveillance applications and detect moving objects using object detection and tracking algorithm  Or Implement any medical image processing application for freely available medical image dataset.
9	<b>Mini Project</b> - Implement image segmentation to detect object in the background of image.

**410252(C) : Software Defined Networks**

Any 5 Assignments and 1 Mini Project are mandatory

**Group 1**

1.	Prepare setup for Mininet network emulation environment with the help of Virtual box and Mininet. Demonstrate the basic commands in Mininet and emulate different custom network topology(Simple, Linear, and Tree).View flow tables.
2	After studying open source POX and Floodlight controller, Install controller and run custom topology using remote controller like POX and floodlight controller. Recognize inserted flows by controllers.
3	Create a SDN environment on Mininet and configure a switch to provide a firewall functionality using POX controller. Ref: <a href="https://github.com/mininet/openflow-tutorial/wiki/Create-Firewall">https://github.com/mininet/openflow-tutorial/wiki/Create-Firewall</a>

4	<p>Using Mininet as an Emulator and POX controller, build your own internet router. Write simple outer with a static routing table. The router will receive raw Ethernet frames and process the packet forwarding them to correct outgoing interface. You must check the Ethernet frames are received and the forwarding logic is created so packets go to the correct interface.</p> <p>Ref: <a href="https://github.com/mininet/mininet/wiki/SimpleRouter">https://github.com/mininet/mininet/wiki/SimpleRouter</a></p>
5	<p>Emulate and manage a Data Center via a Cloud Network Controller: create a multi-rooted tree-like (Clos) topology in Mininet to emulate a data center. Implement specific SDN applications on top of the network controller in order to orchestrate multiple network tenants within a data center environment, in the context of network virtualization and management.</p> <p>Ref:<a href="https://opencourses.uoc.gr/courses/pluginfile.php/13576/mod_resource/content/2/exercise_5.pdf">https://opencourses.uoc.gr/courses/pluginfile.php/13576/mod_resource/content/2/exercise_5.pdf</a></p>
6	<p>Study Experiment: Study in details Cloud seeds automates IAAS using SDN and a high-performance network from Juniper SDN Framework.</p>

### **410252(D) : Advanced Digital Signal Processing**

Any 5 Assignments and 1 Mini Project are mandatory

#### **Group 1**

Use

- A] MATLAB or other equivalent software working with speech and image signals/files and for analysis purpose.
- B] C++ or JAVA for working with sampled data ( n – point data samples of DT/Digital signal)
- C] JAVA or other for image processing assignments

1.	Apply 1-D DFT to observe spectral leakage and frequency analysis of different window sequences, plot the frequency spectrums.
2.	<p>Adaptive FIR and IIR filter design:</p> <p>A] Steepest descent and Newton method, LMS method,</p> <p>B] Adaptive IIR Filter design: Pade Approximation, Least square design</p>
3.	<p>Power spectrum estimation and analysis:</p> <p>Take a speech signal and perform</p> <p>A] Non parametric method: DFT and window sequences</p> <p>B] Parametric methods: AR model parameters</p>
4.	<p>Multi-rate DSP and applications – Decimation, Interpolation, sampling rate conversion</p> <p>A] Take a speech signal with specified sampling frequency. Decimate by factor D(e.g. factor 2)</p> <p>B] Take a speech signal with specified sampling frequency. Interpolate by factor I(e.g. factor 2)</p> <p>C] Sampling rate conversion by factor of I/D</p>
5.	Write a program to calculate LPC coefficients, reflection coefficients using Levinson Durbin algorithm

- |    |   |
|----|---|
| 6. | <p>Feature Extraction of speech signal<br/>           A] Using LPC and other methods<br/>           B] Apply different coding methods: harmonic coding, vector quantization</p> |
|----|---|

**Group 2:**

- |   |   |
|---|---|
| 7 | <p><b>Mini-Project :</b> Discrete Cosine Transform (DCT)<br/>           A] To find DCT of NxN image block<br/>           B] To plot spectrum of the speech signal using DCT and find the correlation of DCT transformed signal<br/>           C] Image filtering using DCT : LPF, edge detection<br/>           D] Image compression using DCT, Image resizing<br/>           OR<br/> <b>Mini-Project :</b> Image Processing<br/>           A] Histogram and Equalization<br/>           B] Image Enhancement Techniques<br/>           C] Image Filtering: LPF, HPF, Sobel/Prewitt Masks<br/>           D] Image Smoothing with special filters: Median, Weiner, Homomorphic filters</p> |
|---|---|

**410252(E) : Open Elective**

- |    |  |
|----|--|
| 1. | Suitable set of programming assignments/Mini-projects for open elective Opted. |
|----|--|

**PART II 410253 : Elective VI****410253(A) Pattern Recognition**

Any 5 Assignments and 1 Mini Project are mandatory
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**Group 1**

- |   |   |
|---|---|
| 1 | Extraction of features using structural and feature space methods for Indian Fruits |
| 2 | Face Recognition using PCA and multiclass LDA.                                      |
| 3 | Fruit shape recognition using Eigen Faces and Fisher Faces                          |
| 4 | Perform sentiment analysis on the IMDB movie reviews dataset                        |
| 5 | Perform a classification task on a dataset of modulated radio signals.              |
| 6 | Perform image segmentation on the Berkley Segmentation dataset                      |

**Group 2**

- |   |  |
|---|--|
| 6 | <b>Mini Project -</b> Real-time face detection in multi-scale images with an attentional cascade of boosted classifiers. |
|---|--|

7

**Mini Project - Printed Devanagari Text Recognition using structural approach.****410253(B) : Soft Computing**

Any 5 Assignments and 1 Mini Project are mandatory

**Group 1**

1	Design an X-OR Gate with feed-forward neural network (also popularly known as a Multilayer Perceptron) classifier.
2	Symmetric and Asymmetric implementation of Particle Swarm Optimization for Traveling Salesman Problem.
3	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.
4	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.
5	Implement genetic algorithm for benchmark function (eg. Square, Rosenbrock function etc) Initialize the population from the Standard Normal Distribution. Evaluate the fitness of all its individuals. Then you will do multiple generation of a genetic algorithm. A generation consists of applying selection, crossover, mutation, and replacement. Use: <ul style="list-style-type: none"><li>• Tournament selection without replacement with tournament size s</li><li>• One point crossover with probability <math>P_c</math></li><li>• bit-flip mutation with probability <math>P_m</math></li><li>• use full replacement strategy</li></ul>

**Group 2**

6	<b>Mini Project -</b> Create a small hybrid system for solving a chosen problem by following the given steps below. <ol style="list-style-type: none"> <li>1. Explain on one page the main characteristics of hybrid systems.</li> <li>2. For the task chosen from the list below, create a multimodular block diagram of a possible solution to the problem.</li> <li>3. Choose appropriate techniques for solving each sub problem represented as a module. What alternatives are there for each of them?</li> <li>4. Create subsystems for solving each of the sub problems. Compile the whole hybrid system.</li> <li>5. Make experiments with the hybrid system and validate the results.</li> </ol>
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- Mini Project:** Handwritten digits recognition  
**Mini Project:** Bank loan approval decision-making system  
**Mini Project:** Stock market prediction  
**Mini Project:** Unemployment prediction  
**Mini Project:** Spoken words recognition, for example, "on"/"off"; "yes"/"no"; "stop"/ "go."  
**Mini Project:** Loan approval

### **410253(C) : Business Intelligence**

Any 5 Assignments and 1 Mini Project are mandatory

#### **Group 1**

1	Import the legacy data from different sources such as (Excel , Sql Server, Oracle etc.) and load in the target system. ( You can download sample database such as Adventure works, Northwind, foodmart etc.)
2	Perform the Extraction Transformation and Loading (ETL) process to construct the database in the Sql server.
3	Create the cube with suitable dimension and fact tables based on ROLAP, MOLAP and HOLAP model.
4	Import the data warehouse data in Microsoft Excel and create the Pivot table and Pivot Chart
5	Perform the data classification using classification algorithm. Or Perform the data clustering using clustering algorithm.

#### **Group 2**

6	<b>Mini Project:</b> Each group of 4 Students (max) assigned one case study for this; A BI report must be prepared outlining the following steps: a) Problem definition, identifying which data mining task is needed. b) Identify and use a standard data mining dataset available for the problem.
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### **410253(D):Quantum Computing**

Any 4 Assignments and 1 Mini Project are mandatory

#### **Group 1**

1	Analyze simple states of superposition and the effect of doing the measurement in different basis states .
2	Build simple quantum circuits with single and two-qubit gates
3	Install Setup for running quantum programs on IBM machines.

4	Analyze the effectiveness of simple error correction scheme
5	Implement quantum programs in NISQ model of computing
6	Make a script for visualizing the energy levels of Hamiltonians.

**Group 2**

6	<b>Mini Project:</b> Build a Quantum Random Number Generator.
7	<b>Mini Project:</b> Implement Grover's Search Algorithm.
7	<b>Mini Project:</b> Use Shor's Algorithm to Factor a Number.

**410253(E) : Open Elective**

1.	Suitable set of programming assignments/Mini-projects for open elective Opted.
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**@The CO-PO Mapping Matrix**

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



## Savitribai Phule Pune University

### Fourth Year of Computer Engineering (2019 Course)

#### 410256: Project Work Stage II

**Teaching Scheme:**

**TH: 06 Hours/Week**

**Credit**

**06**

**Examination Scheme:**

**Term work: 100 Marks**

**Presentation: 50Marks**

#### **Prerequisite Courses: Project Stage I(410248)**

#### **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:**

On completion of the course, student will 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 open questions in the right perspective.

CO4: Link techniques and results from literature as well as actual research and future research 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 Computer Engineering (2019 Course)**  
**410257: 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 [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"> <li>• Lectures/ Guest Lectures</li> <li>• Visits (Social/Field) and reports</li> <li>• Demonstrations or presentations</li> </ul> | <ul style="list-style-type: none"> <li>• Surveys</li> <li>• Mini-Project</li> <li>• Hands on experience on focused topic</li> </ul> |
|--|---|

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

- Written Test
- Demonstrations/ Practical Test
- Presentation or Report

**Audit Course 5 Options**

<b>Audit Course Code</b>	<b>Audit Course Title</b>
AC8-I	Usability Engineering
AC8-II	Conversational Interface
AC8-III	Social Media and Analytics
AC8-IV	MOCC-Learn New Skills
AC8-V	Emotional Intelligence

**Savitribai Phule Pune University, Pune**  
**Fourth Year of Computer Engineering (2019 Course)**  
**410257: 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 Outcome:**

On completion of the course, learner will 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

**Books:**

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”

**Savitribai Phule Pune University, Pune**  
**Fourth Year of Computer Engineering (2019 Course)**  
**410257: 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 Outcome:**

On completion of the course, learner will 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**

#### **Books:**

1. Cathy Pearl, “Designing Voice User Interfaces: Principles of Conversational Experiences”
2. Michael McTear, ZoraidaCallejas, David Griol, “ The Conversational Interface: Talking to Smart Devices”
3. Martin Mitrevski, “Developing Conversational Interfaces for iOS: Add Responsive Voice Control”
4. Srinivasan, “ Hands-On Chatbots and Conversational UI Development: Build chatbots”



**Savitribai Phule Pune University, Pune**  
**Fourth Year of Computer Engineering(2019Course)**  
**410257:Audit Course8**  
**AC8-III: Social Media And Analytics**

This course aims to create awareness among the students regarding social media and analytics.

**Course Objectives:**

- Get strategic understanding of Digital Marketing and Social Media Marketing.
- Understand how to use it for branding and sales.
- Understand its advantages& limitations.
- Become familiar with Best Practices, Tools &Technologies.
- Blend digital and social marketing with offline marketing.
- Plan and manage digital marketing budget.
- Manage Reporting & Tracking Metrics.
- Understand the future of Digital Marketing and prepare for it.

**Course Outcome:**

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

CO1: Develop a far deeper understanding of the changing digital landscape.

CO2: Identify some of the latest digital marketing trends and skill sets needed for today's marketer.

CO3: Successful planning, prediction, and management of digital marketing campaigns

CO4: Assess user interfaces using different usability engineering techniques.

CO5: Implement smart management of different digital assets for marketing needs.

CO6: Assess digital marketing as a long term career opportunity.

**Course Contents:**

1. Digital Marketing, History of Digital Marketing, Importance of Digital Marketing, Effective use of Digital Marketing, Effects of wrong Digital Marketing, Digital Marketing to develop brands, Digital Marketing for sales, Digital Marketing for product and service development.
2. Techniques for effective Email Marketing and pitfalls, Various online email marketing platforms such as Campaign Monitor and Mail Chimp, Web content, web usability, navigation and design, Bookmarking and News Aggregators, Really Simple Syndication (RSS), Blogging, Live Chat, User Generated Content (Wikipedia etc), Multi-media - Video (Video Streaming, YouTube etc), Multi-media - Audio & Podcasting (iTunes etc), Multi-media - Photos/Images (Flickr etc), Google Alerts and Giga Alert (Brand, product and service monitoring online), Crowd sourcing, Virtual Worlds.
3. Search Engine Optimization (SEO), Search Engine Optimization (SEO) tips and techniques, Google Adwords, Google various applications such as 'Google Analytics', Maps, Places etc to enhance a brand's products, services and operations.
4. Facebook & LinkedIn and other Social Media for areal marketing, Utilizing Facebook and LinkedIn's Advertising functionality and Applications, Brand reputation management techniques, Systems for 'buzzmonitoring' for brands, products and services, Effective Public Relations (PR) online and business development.

**References:**

1. Vandana Ahuja, "Digital Marketing", Oxford Press, ISBN:9780199455447, 1<sup>st</sup> Edition.
2. Wiley, Jeanniey, Mullen, David Daniels, David Gilmour, "Email Marketing: An Houra Day, -ISBN:978-0-470-38673-6, 1<sup>st</sup> Edition.



**Savitribai Phule Pune University**  
**Fourth Year of Computer Engineering (2019 Course)**  
**410257: Audit Course 8**  
**AC8 – IV: MOOC-learn New Skill**

This course aims to create awareness among the students regarding various courses available under MOOC and learn new skills through these courses.

**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:**

On completion of the course, , students will be able to

CO1: To acquire additional knowledge and skill.

**About Course**

MOOCs (Massive Open Online Courses) provide affordable and flexible way 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, SWYAM, 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 enhances 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 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 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 infrastructural and facilities for the learners.

**References:**

4. <https://swayam.gov.in/>
5. <https://onlinecourses.nptel.ac.in/>
6. <https://www.edx.org>



**Savitribai Phule Pune University, Pune**  
**Fourth Year of Computer Engineering (2019 Course)**  
**410249: Audit Course 8**  
**AC8 – V: Emotional Intelligence**

This Emotional Intelligence (EI) training course will focus on the five core competencies of emotional intelligence: self-awareness, self-regulation, motivation, empathy and interpersonal skills. Participants will learn to develop and implement these to enhance their relationships in work and life by increasing their understanding of social and emotional behaviors, and learning how to adapt and manage their responses to particular situations. Various models of emotional intelligence will be covered.

**Course Objectives:**

- To develop an awareness of EI models
- To recognize the benefits of EI
- To understand how you 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 your knowledge of emotional patterns in yourself and others
- CO2: Discover how you can manage your emotions, and positively influence yourself and others
- CO3: Build more effective relationships with people at work and at home
- CO4: Positively influence and motivate colleagues, team members, managers
- CO5: Increase the 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, The different levels of emotional awareness, Increase your 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.

**Books:**

1. Daniel Goleman, "[Emotional Intelligence – Why It Matters More Than IQ](#)," , BantamBooks, ISBN-10: 055338371X13: 978-0553383713
2. Steven Stein , "[The EQ Edge](#)" , Jossey-Bass, ISBN : 978-0-470-68161-9
3. Drew Bird , "[The Leader's Guide to Emotional Intelligence](#)" , ISBN: 9781535176002



## Acknowledgement

It is with great pleasure and honor that I share the curriculum for Fourth Year of Computer Engineering (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 Fourth 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. Pramod D. Patil (Dr. D. Y. Patil Institute of Technology, Pimpri), 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!

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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 A. Bhavsar.

**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-**

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### **2. Team Leader- Dr. Pramod D. Patil, Dr. D. Y. Patil Institute of Technology, Pimpri**

### **3. Teams, Course Design -**

Name of Course	Team Coordinator	Team Members	
<b>Design and Analysis of Algorithms</b>	<b>Dr. Santosh V. Chobe</b>	Dr. Sunil Dhore Dr. Rachna Somkunwar Prof. S. P. Pingat	Mrs.Pragati Chaudhari Dr.Vaihsali Tidake
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<b>Elective III : Multimedia Techniques</b>	<b>Dr. B.A.Sonkamble</b>	Dr.Madhuri P. Borawake Prof Gosavi	Mr. Ranjit M. Gawande Prof.Shweta Koparde
<b>Elective III : Cyber Security and Digital Forensics</b>	<b>Dr. Girija G. Chiddarwar</b>	Prof. B.L.Dhote Prof. N. D. Kale Dr.Nikita Kulkarni Dr.Uma Godase	Prof. P.A. Jain
<b>Elective III: Object Oriented Modeling and Design</b>	<b>Prof. Rahul Patil</b>	Mr.Balasaheb S. Tarle Mr.Kishor R. Pathak Mr. Santosh Sambare	Prof.Ashwini A. Jarali Mrs.Neelam Patil
<b>Elective III: Digital Signal Processing</b>	<b>Prof. M.S. Wakode</b>	Prof. P.A. Jain Prof. Yogesh S. Sapnar	
<b>Elective IV:Information Retrieval</b>	<b>Dr. Sharmila Wagh</b>	Dr. Jayadevan R. Mr. Prashant Ahire Dr. Dinesh Hanchate	Mr.Devidas Thosar Dr.S. B . Tambe
<b>Elective IV:GPU Programming and Architecture</b>	<b>Mrs.Jayshree R. Pansare</b>	Mr. S. A. Thanekar Mrs.Asha Sathe Dr.sandip kadam	Dr.Deepak Mane Mr. D.D.Sapkal Prof. Manisha V. Marathe

<b>Elective IV:Mobile Computing</b>	<b>Dr. Manisha Bhende</b>	Dr.R. M. Wahul Dr.Archana Kale Ms. S. V. Bodake	Dr. D. P. Gaikwad Mrs.Nadaph A. Gulab Dr.M.L. Dhore Prof.Yogesh S. Sapnar
<b>Elective IV:Software Testing and Quality Assurance</b>	<b>Dr. Uday C. Patkar</b>	Dr.S.K.Sonkar Dr. S. U. Kadam Mr.Rahul G. Teni Prof. Vina M. Lomte	Dr. Sunil Khatal Ms. Ila Shridhar Savant Prof. Vandana S. Rupnar Prof.Yogesh S. Sapnar
<b>Elective IV:Quantum Computing</b>	<b>Dr. M. U. Kharat</b>	<b>Dr. M. U. Kharat</b>	Prof.Yogesh S Sapnar
<b>Lab Practice III</b>	<b>Dr.Vaihsali Tidake</b>	Dr. Santosh V. Chobe Dr. Sheetal Sonawane DR.S.D. Babar	
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<b>Project Stage I</b>	<b>Dr. Swati A. Bhavsar</b>	<b>Dr. Swati A. Bhavsar</b>	
<b>Audit Course 7</b>	<b>Prof.Satish S. Banait</b>	<b>Prof.Satish S. Banait</b>	
<b>High Performance Computing</b>	<b>Dr. Rachna Somkunwar</b>	Mrs. Archana S. Vaidya Mrs. Rushali Patil Prof.S.P.Khedkar	Dr. G.R.Shinde Mrs.B.Mahalakshmi
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<b>Business Intelligence</b>	<b>Dr. K. Rajeswari</b>	Dr. Zaware S. Nitin Prof. Y.A.Handage Dr. M. R. Sanghavi	Mr. D.G.Modani  Mr. Subhash G. Rathod
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<b>Lab Practice VI</b>	<b>Dr.Kamini A. Shirasath</b>	Dr. M.S.Takalikar  Dr. Sudeep D. Thepade  Dr. Sonali Patil Dr. S. D. Babar	Dr. A.S.Ghotkar Dr. Sulochana Sonkamble Dr. Madhuri A. Potey  Prof. Dr. K. Rajeswari
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