Curriculum
for

Third Year of Computer Engineering
(2019 Course)

(With effect from 2021-22)

[illegible]

Faculty of Science and Technology

Savitribai Phule Pune University
Maharashtra, India

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

links for First and Second Year Computer Engineering Curriculum 2019:

1. [illegible]
2. [illegible]
3. [illegible]

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

Savitribai Phule Pune University

Bachelor of Computer Engineering

Program Outcomes (POs)

Learners are expected to know and be able to–

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

Program Specific Outcomes (PSO)

A graduate of the Computer Engineering Program will demonstrate-

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

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	Database Management Systems	03	--	--	30	70	--	--	--	100	03	--	--	03
310242	Theory of Computation	03	--	--	30	70	--	--	--	100	03	--	--	03
310243	Systems Programming and Operating System	03	--	--	30	70	--	--	--	100	03	--	--	03
310244	Computer Networks and Security	03	--	--	30	70	--	--	--	100	03	--	--	03
310245	Elective I	03	--	--	30	70	--	--	--	100	03	--	--	03
310246	Database Management Systems Laboratory	--	04	--	--	--	25	25	--	50	--	02	--	02
310247	Computer Networks and Security Laboratory	--	02	--	--	--	25	--	25	50	--	01	--	01
310248	Laboratory Practice I	--	04	--	--	--	25	25	--	50	--	02	--	02
310249	Seminar and Technical Communication	--	--	01	--	--	50	--	--	50	--	--	01	01
	Total	15	10	01	150	350	125	50	25	700	15	05	01	21
310250	Audit Course 5												Grade	
										Total Credit	15	05	01	21

310245 Elective I Options:	310250 Audit Course 5 Options:
310245(A) Internet of Things and Embedded Systems	310250(A) Cyber Security
310245(B) Human Computer Interface	310250(B) Professional Ethics and Etiquettes
310245(C) Distributed Systems	310250(C) Learn New Skills
310245(D) Software Project Management	310250(D) Engineering Economics
	310250(E) Foreign Language

Laboratory Practice I

Assignments from **Systems Programming and Operating System** and **Elective I**

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			
		Theory	Practical	Tutorial	Mid-Sem	End-Sem	Term work	Practical	Oral	Total	Theory	Practical	Tutorial	Total
310251	Data Science and Big Data Analytics	04	-	-	30	70	-	-	-	100	04	-	-	04
310252	Web Technology	03	-	-	30	70	-	-	-	100	03	-	-	03
310253	Artificial Intelligence	03	-	-	30	70	-	-	-	100	03	-	-	03
310254	Elective II	03	-	-	30	70	-	-	-	100	03	-	-	03
310255	Internship**	-	-	-	-	-	100 ***	-	-	100	-	-	-	04 ***
310256	Data Science and Big Data Analytics Laboratory	-	04	-	-	-	50	25	-	75	-	02	-	02
310257	Web Technology Laboratory	-	02	-	-	-	25	-	25	50	-	01	-	01
310258	Laboratory Practice II	-	04	-	-	-	50	25	-	75	-	02	-	02
	Total	13	10	-	120	280	225	50	25	775	13	05	-	22
310259	Audit Course 6												Grade	
										Total	13	05	-	22

310254 Elective II Options:

310254(A) Information Security
310254(B) Augmented and Virtual Reality
310254(C) Cloud Computing
310254(D) Software Modeling and Architectures

310259 Audit Course 6 Options:

310259(A) Digital and Social Media Marketing
310259(B) Sustainable Energy Systems
310259(C) Leadership and Personality Development
310259(D) Foreign Language
310259(E) Learn New Skills

Laboratory Practice II:

Assignments from **Artificial Intelligence** and **Elective II**.

****Internship:**

Internship guidelines are provided in course curriculum sheet.

Bonus Week for Theory Courses in Third Year of Engineering, Semester VI:

As per the apex bodies' recommendations and guidelines, it is need of the day to train the pre-final year students for the industrial readiness through internship. As per the guidelines of AICTE, the duration of internship is 4-6 weeks after completion of semester V and before commencement of semester VI, so it is apparent that the contact hours of the TE students need to be managed meticulously. It becomes mandatory as per the structure that 4 credits for internship must earned by the students. **Per semester, <u>15 weeks duration that is suggested ideally by the affiliated university will eventually reduce to limited 12 weeks after the implementation of the revised curriculum (2019 Course). With the mandatory introduction of internship in the structure, we are left with the choice of 4 theory courses in the sixth semester with 12 weeks instead of traditional 15 weeks.</u>** To balance the credits and to address the minimum required contact hours, it is the reasonable choice to allot a bonus 1 week for the each theory course of the sixth semester of Third year of Engineering. The additional one (bonus) week will definitely be instrumental in achieving the targets of minimum contact hours. As such there is no correspondence of credits, load and results earned, the credit allotted per course remain intact despite of the change. **<u>So it is almost imperative that the commencement of VI Semester need to be approx. 2 weeks beyond the schedule.</u>**

General Guidelines

1. Every undergraduate program has its own objectives and educational outcomes. These objectives and outcomes are furnished by considering various aspects and impacts of the curriculum. The **Program Outcomes (POs)** for Engineering 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 handled. The **Course Objectives, Course Outcomes** and **CO-PO mappings matrix** justifies the motives, accomplishments 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 1, 2, 3 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 explain how the learned topics apply to real world situations and need to be explored so as to enable 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. **Exemplars/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 viewpoints.

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

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

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

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

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

achieved. It is recommended to conduct internal monthly mock practical test 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**[*] - Tutorials are never be an individual course but an additional aid to the learners. Tutorials help the learners to supplement the contents of the course with focused efforts on small group of the learners. Tutorial conductors should concentrate more on simplifying the intricacies conveying in 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**[**] 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[1].

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 centre 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].

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

14. ****Internship**

Engineering internships are intended to provide students with an opportunity to apply conceptual knowledge from academics to the realities of the field work/training. The following guidelines are proposed to give academic credit for the internship undergone as a part of the Third Year Engineering curriculum.

[1] [illegible]

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

Abbreviations

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

Semester V

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

Teaching Scheme: **Theory:** 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

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

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

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

Unit II	SQL and PL/SQL	07 Hours

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

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

***Mapping of Course Outcomes for Unit II**	CO1, CO2	
Unit III	**Relational Database Design**	**06 Hours**
Relational Model: Basic concepts, Attributes and Domains, CODD's Rules. **Relational Integrity**: Domain, Referential Integrities, Enterprise Constraints. **Database Design**: Features of Good Relational Designs, Normalization, Atomic Domains and First Normal Form, Decomposition using Functional Dependencies, Algorithms for Decomposition, 2NF, 3NF, BCNF.		
***Exemplar/Case Studies**	Normalize relational database designed in Unit I.	
***Mapping of Course Outcomes for Unit III**	CO3, CO5	
Unit IV	**Database Transaction Management**	**07 Hours**
Introduction to Database Transaction, Transaction states, ACID properties, Concept of Schedule, Serial Schedule. **Serializability**: Conflict and View, Cascaded Aborts, Recoverable and Nonrecoverable Schedules. **Concurrency Control**: Lock-based, Timestamp based Deadlock handling. **Recovery methods**: Shadow-Paging and Log-Based Recovery, Checkpoints. **Log-Based Recovery**: Deferred Database Modifications and Immediate Database Modifications.		
***Exemplar/Case Studies**	Study of Transaction Management in PostgreSQL.	
***Mapping of Course Outcomes for Unit IV**	CO3, CO4	
Unit V	**NoSQL Databases**	**07 Hours**
Introduction to Distributed Database System, Advantages, Disadvantages, CAP Theorem. **Types of Data**: Structured, Unstructured Data and Semi-Structured Data. **NoSQL Database**: Introduction, Need, Features. **Types of NoSQL Databases**: Key-value store, document store, graph, wide column stores, BASE Properties, Data Consistency model, ACID Vs BASE, Comparative study of RDBMS and NoSQL. **MongoDB** (with syntax and usage): CRUD Operations, Indexing, Aggregation, MapReduce, Replication, Sharding.		
***Exemplar/Case Studies**	Use of NoSQL database for processing unstructured data from social media.	
***Mapping of Course Outcomes for Unit V**	CO5, CO6	
Unit VI	**Advances in Databases**	**07 Hours**
Emerging Databases: Active and Deductive Databases, Main Memory Databases, Semantic Databases. **Complex Data Types**: Semi-Structured Data, Features of Semi-Structured Data Models. **Nested Data Types**: JSON, XML. **Object Orientation**: Object-Relational Database System, Table Inheritance, Object-Relational Mapping. **Spatial Data**: Geographic Data, Geometric Data.		
***Exemplar/Case Studies**	Applications of advanced databases in real time environments.	

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

Learning Resources

Text Books:

1. Silberschatz A., Korth H., Sudarshan S., "Database System Concepts", McGraw Hill Publishers, ISBN 0-07-120413-X, 6th edition
2. Connally T, Begg C., "Database Systems", Pearson Education, ISBN 81-7808-861-4
3. Pramod J. Sadalage and Martin Fowler, "NoSQL Distilled", Addison Wesley, ISBN-10: 0321826620, ISBN-13: 978-0321826626

Reference Books:

1. C J Date, "An Introduction to Database Systems", Addison-Wesley, ISBN: 0201144719
2. S.K.Singh, "Database Systems: Concepts, Design and Application", Pearson Education, ISBN 978-81-317-6092-5
3. Kristina Chodorow, Michael Dirolf, "MongoDB: The Definitive Guide", O'Reilly Publications, ISBN: 978-1-449-38156-1
4. Adam Fowler, "NoSQL For Dummies", John Wiley & Sons, ISBN-1118905628
5. Kevin Roebuck, "Storing and Managing Big Data - NoSQL, HADOOP and More", Emereo Pty Limited, ISBN: 1743045743, 9781743045749
6. Joy A. Kreibich, "Using SQLite", O'REILLY, ISBN: 13:978-93-5110-934-1
7. Ivan Bayross, "SQL, PL/SQL the Programming Language of Oracle", BPB Publications ISBN: 9788176569644, 9788176569644
8. Seema Acharya, "Demystifying NoSQL", Wiley Publications, ISBN: 9788126579969

e-Books:

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

MOOC Courses Links:

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
310242: Theory of Computation

Teaching Scheme: **Theory:** 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 understand 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: Devise Turing Machine for the different requirements outlined by theoretical computer science

CO6: Analyze different classes of problems, and study concepts of NP completeness

Course Contents

Unit I	Formal Language Theory and Finite Automata	07 Hours

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 state conversions, Minimization of DFAs.

FA with output: Moore and Mealy machines -Definition, models, state conversions.

#Exemplar/Case Studies	FSM for vending machine, spell checker
*Mapping of Course Outcomes for Unit I	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 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	**Context Free Grammars (CFG) and Context Free Language (CFL)**	**07 Hours**
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. **Simplification of CFG:** Eliminating ϵ-productions, unit productions, useless production, and useless symbols. **Normal Forms:** 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	**Pushdown Automata (PDA)**	**07 Hours**
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	**Turing Machine (TM)**	**07 Hours**
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 Machine, 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	**Computability and Complexity Theory**	**07 Hours**
Computability Theory: Decidable Problems and Un-decidable Problems, Church-Turing Thesis. **Reducibility**: Undecidable Problems that is recursively enumerable, A Simple Un-decidable problem. **Complexity Classes:** 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 NP-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. Daniel Cohen, "Introduction to Computer Theory", Wiley & Sons, ISBN 9788126513345

Reference Books:

1. Sanjeev Arora and Boaz Barak, "Computational Complexity: A Modern Approach", Cambridge University Press, ISBN: 0521424267 9780521424264
2. John Martin, "Introduction to Languages and The Theory of Computation", 3rd Edition, McGraw Hill Education, ISBN-13: 978-1-25-900558-9, ISBN-10: 1-25-900558-5
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, ISBN10 8126533110
5. Michael Sipser, "Introduction to the Theory of Computation", Cengage Learning, ISBN-13: 978-1133187813
6. Vivek Kulkarni, "Theory of Computation", Oxford University Press, ISBN 0-19-808458-4

e-Books :

- https://cglab.ca/~michiel/TheoryOfComputation/TheoryOfComputation.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

MOOCs Courses Links:

- https://nptel.ac.in/courses/106/106/106106049/
- https://nptel.ac.in/courses/106/104/106104028/

@ The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
310243: Systems Programming and Operating System

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

Prerequisites Courses: Programming and Problem Solving (110003), 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 structure 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 06 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 Macros, 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, **Loader schemes**: 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 (OS)** | **07 Hours**

Introduction: Evolution of OS, Operating System Services, Functions of Operating System.

Process Management: Process, Process States: 5 and 7 state model, Process Control Block, Threads, Thread lifecycle, Multithreading Model, Process control system calls.

Process Scheduling: Uniprocessor Scheduling, Scheduling: Preemptive, Non-preemptive, Long-term, Medium-term, Short term scheduling. **Scheduling Algorithms:** FCFS, SJF, RR, and Priority.

#Exemplar/Case Studies	Process management in Linux /Windows/ Android Readers-Writers problem
*Mapping of Course Outcomes for Unit IV	CO4

Unit V | **Synchronization and Concurrency Control** | **07 Hours**

Concurrency: Principles and issues with Concurrency, Mutual Exclusion, Hardware approach, Software approach, Semaphores, Mutex and monitors, Reader writer problem, Producer Consumer problem, Dining Philosopher problem.

Deadlocks: Principles of Deadlock, Deadlock prevention, Deadlock avoidance, Deadlock detection, Deadlock recovery.

#Exemplar/Case Studies	Concurrency Mechanisms: Unix/Linux/Windows
*Mapping of Course Outcomes for Unit V	CO5

Unit VI | **Memory Management** | **07 Hours**

Introduction: Memory Management concepts, Memory Management requirements.

Memory Partitioning: Fixed Partitioning, Dynamic Partitioning, Buddy Systems Fragmentation, Paging, Segmentation, Address translation.

Placement Strategies: First Fit, Best Fit, Next Fit and Worst Fit.

Virtual Memory (VM): 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.

Page Replacement Policies: 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, "Systems 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", 9th 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 81-7366-061-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/
- [illegible]

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/noc18_cs08/preview
- https://www.udemy.com/course/system-programming/

@ The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
310244: Computer Networks and Security

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

Prerequisites Courses: Discrete Mathematics (210241)

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 Network 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

Unit I Introduction To Computer Networks 06 Hours

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

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

Unit II Data Link Layer 06 Hours

Introduction, Functions, **Design Issues:** Services to Network Layer, Framing; **ARQ strategies:** Error detection and correction, Parity Bits, Hamming Codes (11/12-bits) and CRC. **Flow Control Protocols:** Unrestricted Simplex, Stop and Wait, Sliding Window Protocol. **WAN Connectivity:** PPP and HDLC. **MAC Sub layer:** 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.

#Exemplar/Case Studies	Demonstration of DLL protocols on Simulator

*Mapping of Course Outcomes for Unit II	CO2

Unit III	Network Layer	06 Hours

Introduction: Functions of Network layer. **Switching Techniques**: Circuit switching, Message Switching, Packet Switching. **IP Protocol**: Classes of IP (Network addressing), IPv4, IPv6, Network Address Translation, Sub-netting, CIDR. **Network layer Protocols**: ARP, RARP, ICMP, IGMP. **Network Routing and Algorithms**: Static Routing, Dynamic Routing, Distance Vector Routing, Link State Routing, Path Vector. **Routing Protocols**: RIP, OSPF, BGP, MPLS. **Routing in MANET**: AODV, DSR, Mobile IP.

#Exemplar/Case Studies	Demonstration of Routing Protocols on simulator
*Mapping of Course Outcomes for Unit III	CO3

Unit IV	Transport Layer	07 Hours

Process to Process Delivery, Services, Socket Programming. **Elements of Transport Layer Protocols**: Addressing, Connection establishment, Connection release, Flow control and buffering, Multiplexing, Congestion Control. **Transport Layer Protocols**: TCP and UDP, SCTP, RTP, Congestion control and Quality of Service (QoS), Differentiated services, TCP and UDP for Wireless networks.

#Exemplar/Case Studies	Demonstration of Transport layer protocols on Simulator
*Mapping of Course Outcomes for Unit IV	CO4

Unit V	Application Layer	06 Hours

Introduction, Web and HTTP, Web Caching, DNS, Email: SMTP, MIME, POP3, Webmail, FTP, TELNET, DHCP, SNMP.

#Exemplar/Case Studies	Study of Application Layer protocols using network protocol analyzer e.g. Wireshark
*Mapping of Course Outcomes for Unit V	CO5

Unit VI	Security	07 Hours

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.
Security in Network, Transport and Application: Introduction of IPSec, SSL, HTTPS, S/MIME, Overview of IDS and Firewalls.

#Exemplar/Case Studies	Study of security protocols in Network, Transport and Application Layer using network protocol analyzer: Wireshark
*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. Forouzan B. "Data Communications and Networking", 5th Edition, Tata McGraw-Hill Publications, ISBN 0-07-058408-7
2. Andrew S. Tanenbaum, "Computer Networks", 5th Edition, Pearson India, 2013

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", 6th Edition
5. Pachghare V. K., "Cryptography and Information Security", 3rd Edition, PHI

e-Books :

- [illegible]
- http://[illegible]/Data_Communications_and_Networking_By_Behrouz_A.Forouzan.pdf
- [illegible]/ComputerNetworks.pdf
- https://www.tutorialspoint.com/data_communication_computer_network/data_communication_computer_network_tutorial.pdf

Case Study:

- [illegible]
- [illegible]_Network_Design_And_Case_Studies.PDF
- http://vlabs.iitb.ac.in/vlabs-dev/labs_local/computer-networks/labs/explist.php

MOOCs Courses link:

- nptel.ac.in/courses/106/105/[illegible]
- nptel.ac.in/courses/106/105/[illegible]
- nptel.ac.in/courses/106/105/[illegible]
- nptel.ac.in/courses/106/106/[illegible]
- nptel.ac.in/courses/106/105/[illegible]
- 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
CO1	1	-	1	2	2	1	-	-	-	-	1	1
CO2	1	1	1	1	1	-	1	-	-	1	-	-
CO3	1	1	2	1	2	-	-	-	-	-	-	1
CO4	1	2	1	2	2	-	-	-	1	-	1	1
CO5	1	2	-	-	1	-	1	1	-	-	-	-
CO6	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

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

Prerequisites Courses: Digital Electronics and Logic Design (210245)

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

Unit I Introduction to Embedded Systems 07 Hours

Definition, Characteristics of Embedded System, Real time systems, Real time tasks. **Processor basics:** 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.

#Exemplar/Case Studies	Installation of Real Time Operating System
***Mapping of Course Outcomes for Unit I**	CO1,CO2

Unit II Internet of Things : Concepts 07 Hours

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 of IoT.

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

Unit III IoT Design Methodology 07 Hours

IoT Design Methodology: Steps, Basics of IoT Networking, Networking Components, Internet

Structure, Connectivity Technologies, IoT Communication Models and IoT Communication APIs, Sensor Networks, Paradigms of IoT: M2M, SCADA, WSN, RFID.

#Exemplar/Case Studies	Home Automation using IoT communication models and IoT Communication APIs.
***Mapping of Course Outcomes for Unit III**	CO3,CO4

Unit IV	**IoT Protocols**	**07 Hours**

Protocol Standardization for IoT, M2M and WSN Protocols, RFID Protocol, Modbus Protocol, Zigbee Architecture, **IP-based Protocols:** MQTT (Secure), 6LoWPAN, LoRa.

#Exemplar/Case Studies	LoRa based Smart Irrigation System.
***Mapping of Course Outcomes for Unit IV**	CO3,CO5

Unit V	**Cloud Platforms for IoT**	**07 Hours**

Software Defined Networking, Introduction to Cloud Storage Models, Communication API. **WAMP:** AutoBahn for IoT, Xively Cloud for IoT. **Python Web Application Framework:** Django Architecture and application development with Django, Amazon Web Services for IoT, SkyNet IoT Messaging Platform, RESTful Web Services, GRPC, SOAP.

#Exemplar/Case Studies	Smart parking, Forest fire detection.
***Mapping of Course Outcomes for Unit V**	CO4, CO5

Unit VI	**Security in IoT**	**07 Hours**

Introduction, Vulnerabilities of IoT, Security Requirements, Challenges for Secure IoT, Threat Modeling, **Key elements of IoT Security:** Identity establishment, Access control, Data and message security, Non-repudiation and availability, Security model for IoT, Challenges in designing IOT applications, Lightweight cryptography.

#Exemplar/Case Studies	Home Intrusion Detection.
***Mapping of Course Outcomes for Unit VI**	CO2,CO6

Learning Resources

Text Books:

1. **Arshdeep Bahga, Vijay Madisetti,** "Internet of Things – A hands-on Approach", Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515
2. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", 2nd Edition, Wiley Publication, ISBN: 978-1-119-96435-8

Reference Books:

1. [illegible], "Microcontroller and Smart Home Networks", ISBN: 9788170221906, e-ISBN: 9788170221593
2. Charles Crowell, "IoT: Internet of Things for Beginners: An Easy-to-Understand Introduction to IoT", ISBN-13: 979861310[illegible]
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
4. David Etter, "IoT Security: Practical guide book", amazon Kindle Page number, source ISBN: 1548643011.
5. Brian Russell, Drew Van Duren, "Practical Internet of Things Security", Second Edition,

Packt Publishing, ISBN: [illegible]

6. Dr. Shriram K. Vasudevan, Abhishek S. Nagarajan, RMD Sundaram, "Internet of Things", Wiley publication, 2nd Edition, ISBN: [illegible]

e Books :

- [illegible]
- [illegible]

MOOC Courses link :

- https://nptel.ac.in/courses/106/105/106105166/
- [illegible] 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	3	-	2	-	-	-	-	2	-	3	-
CO2	3	3	-	2	1	-	-	-	-	-	-	-
CO3	3	3	3	3	2	1	-	-	2	-	3	-
CO4	1	3	2	2	3	1	-	-	2	1	2	2
CO5	3	3	2	1	3	1	-	-	2	1	2	2
CO6	3	3	-	2	2	2	-	1	-	-	-	1

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

Home

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

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-ordinate the technology with respect to adapting changing user requirements in interacting with computer

Course Outcomes:

On completion of the course, learner should be able to

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

Course Contents

Unit I Introduction and Foundation of HCI 07 Hours

Foundation: Human Memory, **Thinking:** Reasoning and Problem Solving, Emotion, Individual Differences, Psychology and design of Interactive systems. The Computer-Text Entry Devices, Positioning, Pointing, Display devices, Devices for virtual reality and 3D Interaction. The Interaction-Models of Interaction, Frameworks and HCI, Ergonomics, Interaction styles, Experience, Elements of WIMP interface, Interactivity, Measurable Human Factors, The context of interaction. **Importance of User Interface:** Defining user interface, Brief History of Human-Computer interface, Good and Poor Design- Importance of good design.

#Exemplar/Case Studies	Paper prototype – Design elements of GUI
***Mapping of Course Outcomes for Unit I**	CO1,CO6

Unit II Human Perspective in Interaction Design Process 07 Hours

Know your user/client: Understanding how people interact with computers, important human characteristics in Design, Human considerations in design of Business systems, Human Interaction speeds, Performance versus Preference, Methods of gaining an understanding of users, **Miller's** Law.

Design Guidelines: Navigating the interface, Organizing the display, **Getting user's attention**, facilitating data entry. **Principles: Determine user's skill level**, Identify the tasks, Choose an interaction style, Natural Language, Eight Golden rules of Interface design, Prevent errors, Ensuring Human-control while increasing automation. **Theories**: Design-by levels, Stages of action, Consistency, Contextual Theories, Dynamic theories.

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

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

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

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

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

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

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

***Exemplar Case Studies**	GOMS model : Adding items to a cart of e-shopping website.
***Mapping of Course Outcomes for Unit IV**	CO1,CO4

Unit V	**HCI Paradigms**	**07 Hours**

Paradigms for Interaction: Time sharing, Video display units, Programming toolkits, Personal computing, The metaphor, Direct manipulation, Hypertext, Computer supported cooperative work, Agent based interfaces, **Ubiquitous Computing**: Sensor-based and context-aware interaction.

Data integrity versus Data immunity, Handling missing data, Data entry and Input ability, Auditing versus Editing, Retrieval in Physical World, Retrieval in Digital world, Constrained Natural Language inputs, Five stage search framework, Dynamic queries and faceted search, The social aspects of search.

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

***Exemplar Case Studies**	Interface Design: Pattern gesture recognition.
***Mapping of Course Outcomes for Unit V**	CO1,CO4,CO6

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

Designing for Mobile and other devices: Anatomy of a Mobile app, Mobile form factor, Handheld format apps, Tablet format apps, Mini-tablet format apps, Mobile Navigation, Content and control idioms, Browse controls, Navigation and toolbars, Dialogs, 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	IVR in Python Follow and evaluate handheld devices
***Mapping of Course Outcomes for Unit VI**	CO3,CO5,CO6

Learning Resources

Text Books:

1. Alan Dix, Janet Finlay, Russell Beale, "Human Computer Interaction", Pearson Education, 3rd Edition, 2004, ISBN 81-297-0409-9
2. Jenny Preece, Rogers, Sharp, "Interaction Design-beyond human-computer interaction", WILEY-INDIA, ISBN 81-265-0280-9
3. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, "Designing the User Interface: Strategies for Effective Human- Computer Interaction", 5th Edition, Pearson Education Limited, ISBN 978-1-292-03701-1.

Reference Books:

1. Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, "About Face: The Essentials of Interaction Design", 4th edition, WILEY, ISBN 978-1-118-76658-3
2. Mary Beth Rosson and John M. Carroll, "Usability Engineering: Scenario-Based Development of Human-Computer Interaction", Morgan Kaufmann Publishers, ISBN 978-1-558-60712-5
3. Wilbert O. Galitz, "The Essential Guide to user Interface Design", WILEY India, ISBN: 978-81-265-0280-6
4. Jennifer 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 :

- [illegible]
- https://www.ecse.rpi.edu/~nagy/PDF_chrono/2011_Zou_Nagy_complexity_07.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-2
- https://www.edx.org/course/human-computer-interaction-ii-cognition-context-2

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

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

Teaching Scheme:	**Credit:** 03	**Examination Scheme:**
Theory: 03		**Mid-Sem (TH):** 30 Marks
Hours/Week		**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

Unit I	**Introduction**	**07 Hours**

Defining Distributed Systems, Characteristics, Middleware and Distributed Systems. **Design goals:** Supporting resource sharing, Making distribution transparent, Open, Scalable, Pitfalls. **Types of Distributed Systems:** High Performance Distributed Computing, Distributed Information Systems, Pervasive Systems. **Architectural styles:** Layered architectures, Object based architectures, Publish Subscribe architectures. **Middleware organization:** Wrappers, Interceptors, Modifiable middleware. **System architecture:** Centralized, Decentralized, Hybrid, Example architectures – Network File System, Web.

#Exemplar/Case Studies	Case Study of Middleware System that includes Design, Architecture and Application.
***Mapping of Course Outcomes for Unit I**	CO1

Unit II	**Communication**	**07 Hours**

Introduction: 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. **Message Oriented Communication:** Simple Transient Messaging with Sockets, Advanced Transient Messaging, Message Oriented Persistent Communication, Examples. **Multicast Communication:** Application Level Tree-Based Multicasting, Flooding-Based Multicasting, Gossip-Based Data Dissemination.

#Exemplar/Case Studies	Apache Kafka: Distributed Event Streaming Platform , gRPC : Open Source RPC Framework.
***Mapping of Course**	CO2

Outcomes for Unit II	

Unit III	Synchronization	07 Hours

Clock Synchronization: Physical Clocks, Clock Synchronization Algorithms. **Logical Clocks** – Lamport's Logical clocks, Vector Clocks. **Mutual Exclusion:** Overview, Centralized Algorithm, Distributed Algorithm, Token-Ring Algorithm, Decentralized Algorithm. **Election Algorithms:** Bully Algorithm, Ring Algorithm. **Location Systems:** GPS, Logical Positioning of nodes, Distributed Event Matching. **Gossip-Based Coordination:** Aggregation, A Peer-Sampling Service, Gossip-Based Overlay Construction.

#Exemplar/Case Studies	Google Time Synchronization Mechanism in Distributed Computing
*Mapping of Course Outcomes for Unit III	CO3

Unit IV	Naming and Distributed File Systems	07 Hours

Names, Identifiers, Addresses, Flat Naming, Structured Naming, Attributed Based Naming, Introduction to Distributed File Systems, File Service Architecture; **Case study:** Suns Network File System, Andrew File System

#Exemplar/Case Studies	Study of Google File System
*Mapping of Course Outcomes for Unit IV	CO4

Unit V	Consistency and Replication	07 Hours

Introduction: Reasons for Replication, Replication as Scaling Technique; **Data-Centric Consistency Models:** Continuous Consistency, Consistent Ordering of Operations; **Client-Centric Consistency Models:** Eventual Consistency, Monotonic Reads, Monotonic Writes, Read Your Writes, Writes Follow Reads; **Replica Management:** Finding the best server location, Content Replication and Placement, Content Distribution, Managing Replicated Objects; **Consistency Protocols:** Continuous Consistency, Sequential Consistency, Cache Coherence Protocols, Example: Caching, and Replication in the web.

#Exemplar/Case Studies	Study of HDFS Architecture for Data Replication
*Mapping of Course Outcomes for Unit V	CO5

Unit VI	Fault Tolerance	07 Hours

Introduction to Fault Tolerance: Basic Concepts, Failure Models, Failure Masking by Redundancy; **Process Resilience:** Resilience by Process Groups, Failure Masking and Replication, Example: Paxos, Consensus in faulty systems with crash failures, some limitations on realizing fault tolerance, Failure Detection; **Reliable Client Server Communication:** Point to Point Communication, RPC Semantics in the Presence of Failures; **Reliable Group Communication:** Atomic multicast, Distributed commit; **Recovery:** Introduction, Check pointing, Message Logging, Recovery Oriented Computing.

#Exemplar/Case Studies	Study of any Open Source Tool for Building Fault Tolerant System such as Chaos Monkey/Hystrix/Resiliency/Akka
*Mapping of Course	CO6

Outcomes for Unit VI

Learning Resources

Text Books:

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

Reference Books:

1. Christian Cachin, Rachid Guerraoui, Luís Rodrigues, "Introduction to Reliable and Secure Distributed Programming", Springer, 2nd ed. 2011 edition
2. Vijay K. Garg, "Elements of Distributed Computing", Wiley
3. Maarten Van Steen and Andrew S. Tanenbaum, "Distributed Systems", Amazon Digital Services, 3rd edition

e-Books:

- Martin Kleppmann, "Designing Data-Intensive Applications", O'reilly

MOOC Courses links:

- Prof. Rajiv Misra, Distributed Systems, 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/

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
Elective I
310245(D): Software Project Management

Teaching Scheme:	**Credit:** 03	**Examination Scheme:**
Theory: 03 Hours/Week		**Mid-Sem (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: Analyze staffing process for team building and decision making in Software Projects and Management

Course Contents

Unit I Introduction to Software Project Management 07 Hours

Project Definition, Project versus Work 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.

#Exemplar/Case Studies	Analysis of a project using PMBOK concepts
***Mapping of Course Outcomes for Unit I**	CO1

Unit II Project Planning and Project Management Tools 07 Hours

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

#Exemplar/Case Studies	Create software project plan using any tool
***Mapping of Course Outcomes for Unit II**	CO2

Unit III Activity Based Scheduling 07 Hours

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

Unit IV Project Tracking and Control 07 Hours

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

Unit V	**Agile Project Management**	**07 Hours**

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	Analyze the same project using Agile. Create the first stages of the project.
***Mapping of Course Outcomes for Unit V**	CO5

Unit VI	**Staffing in Software Projects**	**07 Hours**

Managing People, Organizational behavior, 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	Analyze a case study for a distributed team and comment.
***Mapping of Course Outcomes for Unit VI**	CO6

Learning Resources

Text Books:

1. Bob Hughes, Mike Cotterell and Rajib Mall, **"Software Project Management"**, Sixth Edition, Tata McGraw Hill, New Delhi, 2017
2. Robert K. Wysocki, "Effective **Software Project Management"**, Wiley Publication, 2011

Reference Books:

1. Ken Schwaber, **"Agile Project Management"**, Microsoft Press, 2004
2. Walker Royce, **"Software Project Management"**, Addison-Wesley, 1998
3. Jalote Pankaj, "Software Project Management in Practice", Addison-Wesley Professional, 2002
4. PMBOK Guide

e-Books:

- [illegible] Software_Project_Management_2nd_Edition.pdf
- [illegible]

MOOC Courses Links:

- https://onlinecourses.nptel.ac.in/noc19_cs70/preview
- Software Project Management - By Prof. Rajib Mall & Prof. Durga Prasad Mohapatra | IIT Kharagpur
- AgileAlliance.org Scrum.org ScrumAlliance.org

@ The CO-PO Mapping Matrix

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

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

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

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, concepts, 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
1.	**ER Modeling and Normalization:** 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.
2.	**SQL Queries:** a. Design and Develop SQL DDL statements which demonstrate the use of SQL objects such as Table, View, Index, Sequence, Synonym, different constraints etc. b. Write at least 10 SQL queries on the suitable database application using SQL DML statements. Note: Instructor will design the queries which demonstrate the use of concepts like Insert, Select, Update, Delete with operators, functions, and set operator etc.
3.	**SQL Queries – all types of Join, Sub-Query and View:** Write at least 10 SQL queries for suitable database application using SQL DML statements. Note: Instructor will design the queries which demonstrate the use of concepts like all types of Join, Sub-Query and View
4.	**Unnamed PL/SQL code block: Use of Control structure and Exception handling is mandatory.** Suggested Problem statement: Consider Tables: 1. Borrower(Roll_no, Name, Date of Issue, Name of Book, Status) 2. Fine(Roll_no, Date, Amt) • Accept Roll_no and Name of Book from user. • Check the number of days (from date of issue). • If days are between 15 to 30 then fine amount will be Rs 5per day. • If no. of days>30, per day fine will be Rs 50 per day and for days less than 30, Rs. 5 per day.

- After submitting the book, status will change from I to R.
- If condition of fine is true, then details will be stored into fine table.
- Also handles the exception by named exception handler or user define exception handler.

OR

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.

Note: Instructor will frame the problem statement for writing PL/SQL block in line with above statement.

4. **Named PL/SQL Block: PL/SQL Stored Procedure and Stored Function.**

Write a Stored Procedure namely proc_Grade for the categorization of student. If marks scored by students in examination is <=1500 and marks>=990 then student will be placed in distinction category if marks scored are between 989 and900 category is first class, if marks899and 825 category is Higher Second Class.

Write a PL/SQL block to use procedure created with above requirement.

Stud_Marks(name, total_marks) Result(Roll,Name, Class)

Note: Instructor will frame the problem statement for writing stored procedure and Function in line with above statement.

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

Write a PL/SQL block of code using parameterized Cursor that will merge the data available in the newly created table N_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.

Note: Instructor will frame the problem statement for writing PL/SQL block using all types of Cursors in line with above statement.

6. **Database Trigger (All Types: Row level and Statement level triggers, Before and After Triggers).**

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.

Note: Instructor will frame the problem statement for writing PL/SQL block for all types of Triggers in line with above statement.

7. **Database Connectivity:**

Write a program to implement MySQL/Oracle database connectivity with any front end language to implement Database navigation operations (add, delete, edit etc.)

Group B: NoSQL Databases

1. **MongoDB Queries:**

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

2. **MongoDB – Aggregation and Indexing:**

Design and Develop MongoDB Queries using aggregation and indexing with suitable example using MongoDB.

3. **MongoDB – Map-reduces operations:**

Implement Map reduces operation with suitable example using MongoDB.

4. **Database Connectivity:**

Write a program to implement Mongo DB database connectivity with any front end language to implement Database navigation operations (add, delete, edit etc.)

Group C: Mini Project

1. Using the **database concepts covered in Group A and Group B**, develop an application with following details:
    1. Follow the same problem statement decided in Assignment -1 of Group A.
    2. Follow the Software Development Life cycle and other concepts learnt in **Software Engineering Course** throughout the implementation.
    3. Develop application considering:
        - Front End : Java/Perl/PHP/Python/Ruby/.net/any other language
        - Backend : MongoDB/MySQL/Oracle
    4. Test and validate application using Manual/Automation testing.
    5. Student should develop application in group of 2-3 students and submit the Project Report which will consist of documentation related to different phases of Software Development Life Cycle:
        - Title of the Project, Abstract, Introduction
        - Software Requirement Specification
        - Conceptual Design using ER features, Relational Model in appropriate Normalize form
        - Graphical User Interface, Source Code
        - Testing document
        - Conclusion.

Note:

- Instructor should maintain progress report of mini project throughout the semester from project group
- Practical examination will be on assignments given above in Group A and Group B only
- Mini Project in this course should facilitate the Project Based Learning among students

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
310247: Computer Networks and Security Laboratory

Teaching Scheme:	Credit: 01	Examination Scheme and Marks:
Practical: 02 Hours/Week		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 their 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

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 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 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 inclusion 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(s) —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

Sr. No.	**Group A (Unit I and II): Attempt any two assignment from Sr. No. 1 to 3. Assignments 4 and 5 are compulsory.**
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.
	Group B (Unit III and IV)
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 a. Say Hello to Each other b. File transfer c. Calculator
10.	Write a program using UDP Sockets to enable file transfer (Script, Text, Audio and Video one file each) between two machines.
	Group C (Unit V and VI): Assignment Sr. No. 11 is Compulsory and attempt any four from Assignments Sr. No 12 to 17
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:
    1. Capture all TCP traffic to/from Facebook, during the time when you log in to your Facebook account
    2. Capture all HTTP traffic to/from Facebook, when you log in to your Facebook account
    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.
    4. Count how many TCP packets you received from / sent to Face book, and how many of each were also HTTP packets.
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
CO1	1	-	1	-	2	1	1	-	-	1	-	1
CO2	-	3	-	1	1	-	-	1	-	-	-	-
CO3	1	2	1	1	-	-	-	1	-	-	1	1
CO4	-	1	2	1	1	1	-	-	-	-	-	1
CO5	2	1	-	-	1	-	-	-	1	-	-	-
CO6	-	1	1	1	1	-	1	-	2	-	-	1

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

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

Companion Course: Systems Programming and Operating System (310243), Elective I (310245)

Course Objectives:

- To learn system programming tools
- To learn modern operating systems
- 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 and 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:** Analyze 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, concepts, 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%20Science
- http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/

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 create a Dynamic Link Library for any mathematical operation and write an application program to test it. (Java Native Interface / Use VB or VC++).

Group B(Any Two Assignments from Sr. No. 4 to 7)

4. Write a program to solve Classical Problems of Synchronization using Mutex and Semaphore.
5. Write a program to simulate CPU Scheduling Algorithms: FCFS, SJF (Preemptive), Priority (Non-Preemptive) and Round Robin (Preemptive).
6. Write a program to simulate Memory placement strategies – best fit, first fit, next fit and worst fit.
7. Write a program to simulate Page replacement algorithm.

Part II : Elective I

Suggested List of Laboratory Experiments/Assignments

(Any Two assignments from each elective subject are compulsory and the 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 / Adruino 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 (NTP/ 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

5. **Execute and Monitor Project Plan**
   - Update % Complete with current task status.
   - Review the status of each task.
   - Compare Planned vs Actual Status
   - Review the status of Critical Path
   - Review resources assignment status
6. **Generate Dashboard and Reports**
   - **Dashboard**
     - Project Overview
     - Cost Overview
     - Upcoming Tasks
   - **Resource Reports**
     - Over-allocated Resources
     - Resource Overview
   - **Cost Reports**
     - Earned Value Report
     - Resource Cost Overview
     - Task Cost Overview
   - **Progress Reports**
     - Critical Tasks
     - Milestone Report
     - Slipping Tasks

@The CO-PO Mapping Matrix

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	-	-	3	1	2	-
CO5	1	2	2	1	-	2	-	-	1	2	1	-
CO6	2	1	2	1	-	2	-	-	2	-	2	1

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

Teaching Scheme	**Credit: 01**	**Examination Scheme and Marks**
Tutorial: 01 Hour/Week		**Term Work: 50 Marks**

Course Objectives:

- To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques.
- To explore the latest technologies.
- To enhance the communication skills.
- To develop problem analysis skills.

Course Outcomes:

On completion of the course, learners will be able to

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

Savitribai Phule Pune University
Third Year of Engineering (2019 Course)
310250: Audit Course 6

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

Criteria

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

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

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

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

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

Audit Course 6 Options

Audit Course Code	Audit Course Title
310250(A)	Cyber Security
310250(B)	Professional Ethics and Etiquette
310250(C)	Learn New Skills- Full Stack Developer
310250(D)	Engineering Economics
310250(E)	Foreign Language (one of Japanese/ Spanish/ French/ German). Course contents for **Japanese (Module 2)** are provided. For other languages institute may design suitably.

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

[illegible]

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

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

Prerequisites: Computer Network and Security (310244)

Course Objectives:

- To motivate students for understanding the various scenarios of cybercrime
- To increase awareness about the cyber issues 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, Cyber stalking, Cyber cafe 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, Key loggers 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, Wiley India Pvt. Ltd. ISBN- 978-81-265-2179-1
2. William Stallings, "Computer Security: Principles and Practices", Pearson 6th Ed, ISBN: 978-0-13-335469-0

Reference Books :

1. Bernard Menezes, "Cryptography and Network Security", TMH, 2 edition, ISBN 978-81-315-1349-1
2. Mark Merkow, "Information Security-Principles and Practices", Pearson Ed., ISBN- 978-81-317-1288-7
3. CK Shyamala et al., "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

Savitribai Phule Pune University
Third Year of Engineering (2019 Course)
Audit Course 5
310250(B): 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 of Dining, Introductory 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.

Reference Books:

1. Ghillyer, "Business Ethics Now", 3rd Edition, McGraw-Hill
2. **George Reynolds**, "Ethics in Information Technology", Cengage Learning, 2004, [illegible]
3. Charles E Harris, Michael S. **Rabins**, "Engineering Ethics", Cengage Learning, 2013, ISBN: 1133934684, 5th Edition

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Engineering (2019 Course)
Audit Course 5
310250(C): 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 prepare the student towards term "Industry ready engineer"

Course Outcomes:

On completion of the course, learner 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 Project: Design and develop an e-commerce a dynamic, scalable and responsive web application. (Sample Project similar problem statements can be formulated).

Reference Books:

1. Laura Lemay, Rafe Colburn and Jennifer Kyrnin, "Mastering HTML, CSS & Javascript Web Publishing", 3ANSS, BPB Publications
2. DT Editorial Services," HTML 5 Black Book (Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP, jQuery)", 2Ed., Dreamtech Press

Note: This is sample contents for **Software Development Using Agility Approach**, however the course instructor may design suitable course giving opportunity to the students for learning new skills.

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Engineering (2019 Course)
Audit Course 6
310258(D): 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, managers, decision makers. Engineering economics touches all 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, learner will be able to–

CO1: Understand economics, the cost money and management in engineering
CO2: Analyze business economics and engineering costs 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: [illegible]
2. James Riggs, "**Engineering** Economics", Tata McGraw-Hill, ISBN – 13: [illegible]

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Engineering (2019 Course)
Audit Course 5
310250(D): Foreign Language (Japanese) Module 3

Prerequisites: We recommend that candidates should have previously completed: AC3-V(210251) and AC 4-V (210258)

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 50 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: Kyoshi, Park(Playground), The Grandpa's Books, The Sun and the Moon, My little sister, Rice fields, My Teacher, People who Fish and People who Farm

Reference Books:

1. **Japanese Kanji and Kana**, "A complete guide to the Japanese writing system", Wolfgang Hadamitzky & Mark Spahn, Tuttle Publishing, Third edition, ISBN: 978-1-4629-1116-2(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 978-1-4629-1369-2 (eBook)

@The CO-PO Mapping Matrix

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

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

Prerequisites Courses: Discrete Mathematics (210241), Database Management Systems (310241)

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 modeling 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

Unit I Introduction to Data Science and Big Data 07 Hours

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.

#Exemplar/Case Studies:	Create academic performance dataset of students and perform data pre-processing using techniques of data cleaning and data transformation.
***Mapping of Course Outcomes for Unit I**	CO1

Unit II Statistical Inference 07 Hours

Need of statistics in Data Science and Big Data Analytics, **Measures of Central Tendency:** Mean, Median, Mode, Mid-range. **Measures of Dispersion:** Range, Variance, Mean Deviation, Standard Deviation. Bayes theorem, Basics and need of hypothesis and hypothesis testing, Pearson Correlation, Sample Hypothesis testing, Chi-Square Tests, t-test.

#Exemplar/Case Studies:	For an employee dataset, create measure of central tendency and its measure of dispersion for statistical analysis of given data.
***Mapping of Course Outcomes for Unit II**	CO2

Unit III Big Data Analytics Life Cycle 07 Hours

Introduction to Big Data, sources of Big Data, **Data Analytic Lifecycle:** Introduction, Phase 1: Discovery, Phase 2: Data Preparation, Phase 3: Model Planning, Phase 4: Model Building, Phase 5: Communication results, Phase 6: Operationalize.

#Exemplar/Case Studies	Case study: Global Innovation Social Network and Analysis (GINA)
***Mapping of Course Outcomes for Unit III**	CO3

Unit IV	**Predictive Big Data Analytics with Python**	**07 Hours**

Introduction, Essential Python Libraries, Basic examples. **Data Preprocessing:** Removing Duplicates, Transformation of Data using function or mapping, replacing values, Handling Missing Data. Analytics Types: Predictive, Descriptive and Prescriptive. **Association Rules:** Apriori Algorithm, FP growth. **Regression:** Linear Regression, Logistic Regression. **Classification:** Naïve Bayes, Decision Trees. **Introduction to Scikit-learn,** Installations, Dataset, mat plotlib, filling missing values, Regression and Classification using Scikit-learn.

#Exemplar/Case Studies	Use IRIS dataset from Scikit and apply data preprocessing methods
***Mapping of Course Outcomes for Unit IV**	CO4,CO2

Unit V	**Big Data Analytics and Model Evaluation**	**07 Hours**

Clustering Algorithms: K-Means, Hierarchical Clustering, Time-series analysis. **Introduction to Text Analysis:** Text-preprocessing, Bag of words, TF-IDF and topics. Need and Introduction to social network analysis, Introduction to business analysis. **Model Evaluation and Selection:** Metrics for Evaluating Classifier Performance, Holdout Method and Random Sub sampling, Parameter Tuning and Optimization, Result Interpretation, Clustering and Time-series analysis using Scikit-learn, sklearn. metrics, Confusion matrix, AUC-ROC Curves, Elbow plot.

#Exemplar/Case Studies	Use IRIS dataset from Scikit and apply K-means clustering methods
***Mapping of Course Outcomes for Unit V**	CO4, CO5

Unit VI	**Data Visualization and Hadoop**	**07 Hours**

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. **Data Visualization using Python:** Line plot, Scatter plot, Histogram, Density plot, Box- plot.

#Exemplar/Case Studies	Use IRIS dataset from Scikit and plot 2D views of the dataset
***Mapping of Course Outcomes for Unit VI**	CO5, CO6

Learning Resources

Text Books:

1. David Dietrich, Barry Hiller, "Data Science and Big Data Analytics", EMC education services, Wiley publication, 2012, ISBN0-07-120413-X
2. Jiawei Han, Micheline Kamber, and Jian Pei, "Data Mining: Concepts and Techniques" Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807

Reference Books :

1. EMC Education Services, "Data Science and Big Data Analytics- Discovering, analyzing Visualizing and Presenting Data"
2. DT Editorial Services, "Big Data, Black Book", DT Editorial Services, ISBN 9789351197577, 2015 Edition
3. Chirag Shah, "A Hands-On Introduction To Data Science", Cambridge University Press, (2020), ISBN : ISBN 978-1-108-47244-9
4. Wes McKinney, "Python for Data Analysis", O' Reilly media, ISBN : 978-1-449-31979-3
5. Trent Hauk, "Scikit-learn Cookbook", Packt Publishing, ISBN: 9781787286382

6. Jenny Kim, Benjamin Bengfort, **"Data Analytics with Hadoop"**, OReilly Media, Inc., ISBN 9781491913703
7. Venkat Ankam, "Big Data Analytics", Packt Publishing, ISBN: 9781785884696
8. Seema Acharya, Subhashini Chellappan, "Big Data And Analytics", **Wiley publications**, ISBN: 9788126579518

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://tanthiamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf
- Introducing Data Science by Davy Cielen, Manning Publications
- Introducing Data Science (PDF)
- Handbook for 'visualizing': a handbook for data driven design by Andy Kirk
- 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_days_pdf&utm_medium=all&utm_content=[illegible]
- Learning with Python: How to think like a computer scientist
  http://openbookproject.net/thinkcs/python/english2e/
- Python for everybody
  http://do1.dr-chuck.com/pythonlearn/EN_us/pythonlearn.pdf
- Scikit Learn Tutorial
  https://scikit-learn.org/stable/

MOOCs Courses link:

- 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

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	-	-	1
CO3	2	1	2	1	-	1	-	-	1	-	-	1
CO4	1	1	1	1	2	-	-	-	1	-	-	1
CO5	1	1	1	1	2	-	-	-	1	-	-	1
CO6	1	1	1	2	2	-	-	-	1	-	-	1

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
310252: Web Technology

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

Prerequisites Courses: Database Management Systems (310241),
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 Reply feature)
***Mapping of Course Outcomes for Unit II**	CO2

Unit III	Java Servlets and XML	07 Hours

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

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

Unit IV	JSP and Web Services	07 Hours

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

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

Unit V	Server Side Scripting Languages	07 Hours

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

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

Unit VI	Ruby and Rails	07 Hours

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

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

Learning Resources

Text Books:

1. Jeffrey C.Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035

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://w3c.github.io/
- http://php.net/
- https://jquery.com/
- https://developer.mozilla.org/en-US/docs/AJAX
- http://www.tutorialspoint.com/ws/

MOOC Courses link:

- http://www.nptelvideos.in/2012/11/internet-technologies.html
- https://freevideolectures.com/course/2308/internet-technology/27 Video lectures by Prof. Indranil Sengupta, IIT Kharagpur
- https://www.digimat.in/nptel/courses/video/106105191/L01.html
- http://www.nptelvideos.com/php/php_video_tutorials.php

@ The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
310253: Artificial Intelligence

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

Prerequisites Courses: Programming and Problem solving (110003),
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

Unit I	**Introduction**	**07 Hours**

Introduction to Artificial Intelligence, Foundations of Artificial Intelligence, History of Artificial Intelligence, State of the Art, Risks and Benefits of AI, Intelligent Agents, Agents and Environments, Good Behavior: Concept of Rationality, Nature of Environments, Structure of Agents.

#Exemplar/Case Studies	[illegible] How The U.S. Postal Service Is Using AI And Robots To Prepare For The 4th Industrial Revolution
***Mapping of Course Outcomes for Unit I**	CO1, CO4

Unit II	**Problem-solving**	**07 Hours**

Solving Problems by Searching, Problem-Solving Agents, Example Problems, Search Algorithms, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions, Search in Complex Environments, Local Search and Optimization Problems.

#Exemplar/Case Studies	4th Industrial Revolution Using AI, Big Data And Robotics
***Mapping of Course Outcomes for Unit II**	CO2, CO4

Unit III	Adversarial Search and Games	07 Hours

Game Theory, Optimal Decisions in Games, Heuristic Alpha–Beta Tree Search, Monte Carlo Tree Search, Stochastic Games, Partially Observable Games, Limitations of Game Search Algorithms, Constraint Satisfaction Problems (CSP), Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs

#Exemplar/Case Studies	Machine Learning At Google: The Amazing Use Case Of Becoming A Fully Sustainable Business
***Mapping of Course Outcomes for Unit III**	CO3, CO4

Unit IV	Knowledge	07 Hours

Logical Agents, Knowledge-Based Agents, The Wumpus World, Logic, Propositional Logic: A Very Simple Logic, Propositional Theorem Proving, Effective Propositional Model Checking, Agents Based on Propositional Logic, First-Order Logic, Representation Revisited, Syntax and Semantics of First-Order Logic, Using First-Order Logic, Knowledge Engineering in First-Order Logic.

#Exemplar/Case Studies	BBC To Launch AI - Enabled Interactive Radio Show For Amazon Echo And Google Home Chat bots
***Mapping of Course Outcomes for Unit IV**	CO3, CO4

Unit V	Reasoning	07 Hours

Inference in First-Order Logic, Propositional vs. First-Order Inference, Unification and First-Order Inference, Forward Chaining, Backward Chaining, Resolution, Knowledge Representation: Ontological Engineering, Categories and Objects, Events, Mental Objects and Modal Logic, Reasoning Systems for Categories, Reasoning with Default Information

#Exemplar/Case Studies	The Amazing Ways How Wikipedia Uses Artificial Intelligence
***Mapping of Course Outcomes for Unit V**	CO4, CO5

Unit VI	Planning	07 Hours

Automated Planning, Classical Planning, Algorithms for Classical Planning, Heuristics for Planning, Hierarchical Planning, Planning and Acting in Nondeterministic Domains, Time, Schedules, and Resources, Analysis of Planning Approaches, Limits of AI, Ethics of AI, Future of AI, AI Components, AI Architectures

#Exemplar/Case Studies	The Amazing Ways Samsung Is Using Big Data, Artificial Intelligence And Robots To Drive Performance
***Mapping of Course Outcomes for Unit VI**	CO4, CO6

Learning Resources

Text Books:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third edition, Pearson, 2003, ISBN :10: 0136042597
2. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education(India), 2013, ISBN : 978-1-25-902998-1
3. Elaine Rich, Kevin Knight and Nair, "Artificial Intelligence", TMH, ISBN-978-0-07-008770-5

Reference Books:

1. Nilsson Nils J., "Artificial Intelligence: A new Synthesis", Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4
2. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley Publishing Company, ISBN: 0-201-53377-4
3. Andries P. Engelbrecht-Computational Intelligence: An Introduction, 2nd Edition-Wiley India- ISBN: 978-0-470-51250-0
4. Dr. Lavika Goel, "Artificial Intelligence: Concepts and Applications", Wiley publication, ISBN: 9788126519934
5. Dr. Nilakshi Jain, "Artificial Intelligence, As per AICTE: Making a System Intelligent", Wiley publication, ISBN: 9788126579946

e-Books :

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

MOOCs Courses link:

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
Elective II
310254(A): Information Security

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

Prerequisite 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

Unit I	**Introduction to Information Security**	**07 Hours**

Foundations of Security, Computer Security Concepts, The OSI Security Architecture, Security attacks, Security services, Security mechanisms, A Model for Network Security

#Exemplar/Case Studies	Open Source/ Free/ Trial Tools: Clam AV antivirus engine, Anti Phishing, Anti Spyware, Wireshark
***Mapping of Course Outcomes for Unit I**	CO1

Unit II	**Symmetric Key Cryptography**	**07 Hours**

Classical Encryption Techniques: Stream Ciphers, Substitution Techniques: Caesar Cipher, Mono alphabetic Cipher, Play fair Cipher, Hill Cipher, Poly alphabetic Cipher, Transposition Techniques, Block Cipher and Data encryption standards, 3DES, Advanced Encryption standard

#Exemplar/Case Studies	Open Source/ Free/ Trial Tools: crypt tool
***Mapping of Course Outcomes for Unit II**	CO2

Unit III	**Asymmetric Key Cryptography**	**07 Hours**

Number theory: Prime numbers, Fermat and Euler theorems, Testing for primality, Chinese remainder theorem, discrete logarithms. Public Key Cryptography and RSA, Key Management, Diffie Hellman key exchange, ElGamal algorithm, Elliptic Curve Cryptography

#Exemplar/Case Studies	Open Source Free/ Trial Tools: cryptool
***Mapping of Course Outcomes for Unit III**	CO2

Unit IV	Data Integrity Algorithms And Web Security	06 Hours

Cryptographic Hash Function: 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. **Message Authentication Codes:** Message Authentication Requirements, Message Authentication Functions, Requirements for Message Authentication Codes, Security of MACs. **Digital Signatures:** Digital Signatures, Schemes, Digital Signature standard, PKI X.509 Certificate.

Web Security issues, HTTPS, SSH, Email security: PGP, S/MIME, IP Security: IPSec

#Exemplar/Case Studies	Open Source Free/ Trial Tools: Open SSL, Hash Calculator Tool: MD5, SHA1, SHA256, SHA 512
***Mapping of Course Outcomes for Unit IV**	CO3

Unit V	Network and System Security	07 Hours

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, **Intrusion prevention system:** 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

#Exemplar/Case Studies	Open Source Free/ Trial Tools: DOS Attacks, DDOS attacks, Wireshark, Cain and Abel, iptables/ Windows Firewall, Suricata, fail2ban, Snort.
***Mapping of Course Outcomes for Unit V**	CO4

Unit VI	Cyber Security and Tools	07 Hours

Introduction, Cybercrime and Information Security, Classifications 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.

#Exemplar/Case Studies	Study of any two network security scanners: Nmap, Metasploit, Open VAS, Aircrack, Nikto, Samurai, Safe3, etc.
***Mapping of Course Outcomes for Unit VI**	CO5

Learning Resources

Text Books :

1. William Stallings, "Cryptography and Network Security Principals and Practice", Seventh edition, Pearson, ISBN : 978-1-292-15858
2. William Stallings, Lawrie Brown, "Computer Security Principles and Practice", 3rd_Edition, Pearson, ISBN : 978-0-13-377392-7
3. Nina Godbole, Sunit 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. Joseph Kizza, "Computer Network Security and Cyber Ethics", McFarland & Company, Inc., Publishers, Fourth Edition
5. Michael Whitman and Herbert Mattord, "Principles of Information Security", Course Technology Inc., 7th edition
6. Nayna Godbole, "Information Systems Security: Security Management, Metrics, Frameworks and Best Practices", Wiley publication, ISBN: 9788126564057

e-Books :

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

MOOCs Courses link

- NPTEL Course on https://nptel.ac.in/courses/106/106/106106129/ IIT Madras, Prof. V. Kamakoti
- Introduction to cyber security, "https://swayam.gov.in/nd2_nou19_cs08/preview" by Dr. Jeetendra Pande | Uttarakhand Open University, Haldwani

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
Elective II
310254(B): Augmented and Virtual Reality

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

Prerequisites Course: 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 applications that allows users to interact with the immersive AR 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 interfaces 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	07 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	07 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.

*Mapping of Course Outcomes for Unit II	CO2

Unit III	Representing and Rendering the Virtual World	08 Hours

Representation of the Virtual World: Visual Representation in Virtual Reality, Aural Representation and Haptic Representation in Virtual Reality.

Rendering Systems:

Visual Rendering Systems: Visual Rendering Methods, Geometrically Based Rendering Systems, Nongeometric Rendering Systems, Rendering Complex Visual Scenes, Computer Graphics System Requirements.

Aural Rendering Systems: Visual Rendering Methods, Rendering Complex Sounds, Sound Generation Hardware, Internal Computer Representation.

Haptic Rendering Systems: Haptic Rendering Methods, Rendering Complex Haptic Scenes with Force Displays, Haptic Rendering Techniques.

#Exemplar/Case Studies	GHOST (General Haptics Open Software Toolkit) software development toolkit.
*Mapping of Course Outcomes for Unit III	CO3

Unit IV	Interacting with the Virtual World and Virtual Reality Experience	07 Hours

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.

#Exemplar/Case Studies	Side effects of using VR systems: VR sickness and Study of Interface design of any VR game.
*Mapping of Course Outcomes for Unit IV	CO4

Unit V	Augmented Reality	08 Hours

Concepts: Computer Graphics, Dimensionality, Depth Cues, Registration and Latency. Working of Augmented Reality, Augmented Reality Hardware (Sensors, Processors, Displays), Ingredients of an AR Experience.

#Exemplar/Case Studies	Augmented Reality (AR) and Virtual Reality (VR) headsets mainly find applications in gaming, movies, and other forms of entertainment. Israeli 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.
*Mapping of Course Outcomes for Unit V	CO4, CO5

Unit VI	Augmented Reality Software and Mobile Augmented Reality	07 Hours

Augmented Reality Systems, Software Components, Software Tools for Content Creation, Interaction in Augmented Reality. **Augmented Reality Techniques**: Marker based and Marker less 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:

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

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
Elective II
310254(C): Cloud Computing

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

Prerequisites Courses: Computer Networks and Security (310244), Distributed Systems (410245C)

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

Unit I | **Introduction to Cloud Computing** | **07 Hours**

Importance of Cloud Computing, Characteristics, Pros and Cons of Cloud Computing, Migrating into the Cloud, Seven-step model of migration into a Cloud, Trends in Computing. **Cloud Service Models:** SaaS, PaaS, IaaS, Storage. **Cloud Architecture:** Cloud Computing Logical Architecture, Developing Holistic Cloud Computing Reference Model, Cloud System Architecture, Cloud Deployment Models.

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

Unit II | **Data Storage and Cloud Computing** | **07 Hours**

Data Storage: Introduction to Enterprise Data Storage, Direct Attached Storage, Storage Area Network, Network Attached Storage, Data Storage Management, File System, Cloud Data Stores, Using Grids for Data Storage. **Cloud Storage:** Data Management, Provisioning Cloud storage, Data Intensive Technologies for Cloud Computing. **Cloud Storage from LANs to WANs:** Cloud Characteristics, Distributed Data Storage.

#Exemplar/Case Studies	Online Book Marketing Service, Online Photo Editing Service

*Mapping of Course Outcomes for Unit II	CO2

Unit III	Virtualization in Cloud Computing	07 Hours

Introduction: Definition of Virtualization, Adopting Virtualization, Types of Virtualization, Virtualization Architecture and Software, Virtual Clustering, Virtualization Application, Pitfalls of Virtualization. **Grid, Cloud and Virtualization:** Virtualization in Grid, Virtualization in Cloud, Virtualization and Cloud Security. **Virtualization and Cloud Computing:** Anatomy of Cloud Infrastructure, Virtual infrastructures, CPU Virtualization, Network and Storage Virtualization.

#Exemplar/Case Studies	Xen: Para virtualization, VMware: Full Virtualization, Microsoft Hyper-V
*Mapping of Course Outcomes for Unit III	CO3

Unit IV	Cloud Platforms and Cloud Applications	07 Hours

Amazon Web Services (AWS): Amazon Web Services and Components, Amazon Simple DB, Elastic Cloud Computing (EC2), Amazon Storage System, Amazon Database services (Dynamo DB). **Microsoft Cloud Services:** Azure core concepts, SQL Azure, Windows Azure Platform Appliance. **Cloud Computing Applications:** Healthcare: ECG Analysis in the Cloud, Biology: Protein Structure Prediction, Geosciences: Satellite Image Processing, Business and Consumer Applications: CRM and ERP, Social Networking, Google Cloud Application: Google App Engine. Overview of OpenStack architecture.

#Exemplar/Case Studies	Multiplayer Online Gaming
*Mapping of Course Outcomes for Unit IV	CO4

Unit V	Security in Cloud Computing	07 Hours

Risks in Cloud Computing: Risk Management, Enterprise-Wide Risk Management, Types of Risks in Cloud Computing. **Data Security in Cloud:** Security Issues, Challenges, advantages, Disadvantages, Cloud Digital persona and Data security, Content Level Security. **Cloud Security Services:** Confidentiality, Integrity and Availability, Security Authorization Challenges in the Cloud, Secure Cloud Software Requirements, Secure Cloud Software Testing.

#Exemplar/Case Studies	Cloud Security Tool: Azure.
*Mapping of Course Outcomes for Unit V	CO5

Unit VI	Advanced Techniques in Cloud Computing	07 Hours

Future Trends in Cloud Computing, Mobile Cloud, **Automatic Cloud Computing:** Comet Cloud. **Multimedia Cloud:** IPTV, Energy Aware Cloud Computing, Jungle Computing, Distributed Cloud Computing Vs Edge Computing, Containers, Docker, and Kubernetes, Introduction to DevOps. **IOT and Cloud Convergence:** The Cloud and IoT in your Home, The IOT and cloud in your Automobile, PERSONAL: IoT in Healthcare.

#Exemplar/Case Studies	Case studies on DevOps: Docker/Jenkins, Kubernetes
*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. A. Srinivasan, J. Suresh, "Cloud Computing: A Practical Approach for Learning and Implementation", Pearson, ISBN 978-81-317-7651-3
2. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, "Mastering Cloud Computing", McGraw Hill Education, ISBN-13: 978-1-25-902995-0

Reference Books:

1. James Bond, "The Enterprise Cloud", O'Reilly Media, Inc. ISBN: 9781491907627
2. Dr. Kris Jamsa, "Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more", Wiley Publications, ISBN: 978-0-470-97389-9
3. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach", 2010, The McGraw-Hill.
4. Gautam Shroff, "ENTERPRISE CLOUD COMPUTING Technology, Architecture, Applications", Cambridge University Press, ISBN: 9780511778476
5. Tim Mather, Subra K, Shahid L., "Cloud Security and Privacy", Oreilly, ISBN-13 978-81-8404-815-5
6. Dr. Kumar Saurabh, "Cloud Computing: Architecting Next-Gen Transformation Paradigms", Wiley publication, ISBN: [illegible]
7. Rishabh Sharma, "Cloud Computing: Fundamentals, Industry Approach and Trends", Wiley publication, ISBN

e-Books :

- https://sjceodisha.in/wp-content/uploads/2019/09/CLOUD-COMPUTING-Principles-and-Paradigms.pdf
- https://studytm.files.wordpress.com/2014/03/hand-book-of-cloud-computing.pdf
- https://arpitapatel.files.wordpress.com/2014/10/cloud-computing-bible1.pdf
- https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.500-291r2.pdf

MOOCs Courses link:

- Cloud Computing https://onlinecourses.nptel.ac.in/noc21_cs14/preview
- Cloud Computing and Distributed Systems 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/106104182/L25.html

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
Elective II
310245(D): Software Modeling and Architectures

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

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

Companion Course: Laboratory Practice I (310248)

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, learner 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 modeling tools for designing and modeling

Course Contents

Unit I	Concepts of Software Modeling	07 Hours

Software Modeling: Introduction to Software Modeling, Advantages of modeling, Principles of modeling. **Evolution of Software Modeling and Design Methods:** Object oriented analysis and design methods, Concurrent, Distributed Design Methods and Real-Time Design Methods, Model Driven Architecture (MDA), 4+1 Architecture, Introduction to UML, UML building Blocks, COMET Use Case-Based Software Life Cycle. **Requirement Study:** Requirement Analysis, SRS design, Requirement Modeling. **Use Case:** Actor and Use case identification, Use case relationship (Include, Extend, Use case Generalization, Actor Generalization), Use case template.

#Exemplar/Case Studies	Requirement modeling and use case modeling for Real life application (e.g., Online shopping system)
*Mapping of Course Outcomes for Unit I	CO1, CO2

Unit II	Static Modeling	07 Hours

Study of classes (analysis level and design level classes). **Methods for identification of classes:** RUP (Rational Unified Process), CRC (Class, Responsibilities and Collaboration), Use of Noun Verb analysis (for identifying entity classes, controller classes and boundary classes). **Class Diagram:** Relationship between classes, Generalization/Specialization Hierarchy, Composition and Aggregation Hierarchies, Association Classes, Constraints.
Object diagram, Package diagram, Component diagram, Composite Structure diagram, Deployment Diagram.

*Exemplar Case Studies	UML Static Diagrams for Real life applications (e.g., Online shopping system)
*Mapping of Course Outcomes for Unit II	CO1, CO2

Unit III	Dynamic Modeling	07 Hours

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.

*Exemplar Case Studies	UML dynamic Diagrams of the Real life applications
*Mapping of Course Outcomes for Unit III	CO1, CO2

Unit IV	Software Architecture and Quality Attributes	07 Hours

Introduction to Software Architecture, Importance of Software Architecture, Architectural Structures and Views. **Architectural Pattern:** Common module, Common component-and-connector, Common allocation.
Quality Attributes: Architecture and Requirements, Quality Attributes and Considerations.

*Exemplar Case Studies	Case study of any real-life application
*Mapping of Course Outcomes for Unit IV	CO3

Unit V	Architectural Design and Documentation	07 Hours

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.

*Exemplar Case Studies	Air Traffic Control
*Mapping of Course Outcomes for Unit V	CO4, CO5

Unit VI	Design Patterns	07 Hours

Design Patterns: Introduction, Different approaches to select Design Patterns. **Creational patterns:** Singleton, Factory; Structural pattern: Adapter, Proxy; **Behavioral Patterns:** Iterator, Observer Pattern with applications.

*Exemplar Case Studies	Flight Simulation
*Mapping of Course Outcomes for Unit VI	CO6, CO5

Learning Resources

Text Books:

1. Jim Arlow, Ila Neustadt, "UML 2 and the unified process –practical object-oriented analysis and design", Addison Wesley, Second edition, ISBN 978-0201770605.
2. Len Bass, Paul Clements, Rick Kazman, "Software Architecture in Practice", Second Edition, Pearson, ISBN 978-81-775-8996-2.
3. Erich Gamma, "Design Patterns", Pearson, ISBN 0-201-63361-2.

Reference Books:

1. Hassan Gomaa, "Software Modeling and Design- UML, Use cases, Patterns and Software Architectures", Cambridge University Press, 2011, ISBN 978-0-521-76414-8
2. Grady Booch, James Rumbaugh, Ivar Jacobson, "The unified modeling language user guide", Pearson Education, Second edition, 2008, ISBN 0-321-26797-4
3. Ian Sommerville, "Software Engineering", Addison and Wesley, ISBN 0-3-[illegible]

e-Books :

- https://ebookpdf.com/roger-s-pressman-software-engineering
- https://[illegible].files.wordpress.com/2018/02/pressman-software-engineering.pdf
- https://[illegible].files.wordpress.com/2011/06/the-unified-modeling-language-user-guide-by-grady-booch-james-rumbaugh-ivar-jacobson.pdf
- http://[illegible]

MOOCs Courses link

- https://nptel.ac.in/courses/106/105/106105224/
- https://onlinecourses.nptel.ac.in/noc20_cs84/preview
- https://onlinecourses.nptel.ac.in/noc20_cs44/preview

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
310256: Internship**

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 career 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. Organization/NGO/MSME/Rural Internship/ Innovation/IPR/Entrepreneurship. Student may choose either to work on innovation or entrepreneurial activities resulting in startup 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 [1]. 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 & Presentation Skills
- Team Work
- Creativity
- Planning & Organizational skills
- Adaptability
- Analytical Skills
- Attitude & 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 recommended parameters include as- 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

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

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
310256: Data Science and Big Data Analytics Laboratory

Teaching Scheme	Credit	Examination Scheme and Marks
Practical: 04 Hours/Week	02	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"
- [illegible]

Suggested List of Laboratory Experiments/Assignments

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

Sr. No.	Group A : Data Science

1. **Data Wrangling, I**

Perform the following operations using Python on any open source dataset (e.g., data.csv)

1. Import all the required Python Libraries.
2. Locate an open source data from the web (e.g., https://www.kaggle.com). Provide a clear description of the data and its source (i.e., URL of the web site).
3. Load the Dataset into pandas data frame.
4. Data Preprocessing: check for missing values in the data using pandas isnull(), describe() function to get some initial statistics. Provide variable descriptions. Types of variables etc. Check the dimensions of the data frame.
5. Data Formatting and Data Normalization: Summarize the types of variables by checking the data types (i.e., character, numeric, integer, factor, and logical) of the variables in the data set. If variables are not in the correct data type, apply proper type conversions.
6. Turn categorical variables into quantitative variables in Python.

In addition to the codes and outputs, explain every operation that you do in the above steps and explain everything that you do to import/read/scrape the data set.

2. **Data Wrangling II**

Create an "Academic performance" dataset of students and perform the following operations using Python.

1. Scan all variables for missing values and inconsistencies. If there are missing values and/or inconsistencies, use any of the suitable techniques to deal with them.
2. Scan all numeric variables for outliers. If there are outliers, use any of the suitable techniques to deal with them.
3. Apply data transformations on at least one of the variables. The purpose of this transformation should be one of the following reasons: to change the scale for better understanding of the variable, to convert a non-linear relation into a linear one, or to decrease the skewness and convert the distribution into a normal distribution.

Reason and document your approach properly.

3. **Descriptive Statistics - Measures of Central Tendency and variability**

Perform the following operations on any open source dataset (e.g., data.csv)

1. Provide summary statistics (mean, median, minimum, maximum, standard deviation) for a dataset (age, income etc.) with numeric variables grouped by one of the qualitative (categorical) variable. For example, if your categorical variable is age groups and quantitative variable is income, then provide summary statistics of income grouped by the age groups. Create a list that contains a numeric value for each response to the categorical variable.
2. Write a Python program to display some basic statistical details like percentile, mean, standard deviation etc. of the species of 'Iris-setosa', 'Iris-versicolor' and 'Iris-versicolor' of iris.csv dataset.

Provide the codes with outputs and explain everything that you do in this step.

4. **Data Analytics I**

Create a Linear Regression Model using Python/R to predict home prices using Boston Housing Dataset (https://www.kaggle.com/c/boston-housing). The Boston Housing dataset contains information about various houses in Boston through different parameters. There are 506 samples and 14 feature variables in this dataset.

The objective is to predict the value of prices of the house using the given features.

5. **Data Analytics II**
   1. Implement logistic regression using Python/R to perform classification on Social_Network_Ads.csv dataset.
   2. Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given dataset.

6. **Data Analytics III**
   1. Implement Simple Naïve Bayes classification algorithm using Python/R on iris.csv dataset.
   2. Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given dataset.

7. **Text Analytics**
   1. Extract Sample document and apply following document preprocessing methods: Tokenization, POS Tagging, stop words removal, Stemming and Lemmatization.
   2. Create representation of document by calculating Term Frequency and Inverse Document Frequency.

8. **Data Visualization I**
   1. Use the inbuilt dataset 'titanic'. The dataset contains 891 rows and contains information about the passengers who boarded the unfortunate Titanic ship. Use the Seaborn library to see if we can find any patterns in the data.
   2. Write a code to check how the price of the ticket (column name: 'fare') for each passenger is distributed by plotting a histogram.

9. **Data Visualization II**
   1. Use the inbuilt dataset 'titanic' as used in the above problem. Plot a box plot for distribution of age with respect to each gender along with the information about whether they survived or not. (Column names : 'sex' and 'age')
   2. Write observations on the inference from the above statistics.

10) **Data Visualization III**

Download the Iris flower dataset or any other dataset into a DataFrame. (e.g., https://archive.ics.uci.edu/ml/datasets/Iris). Scan the dataset and give the inference as:

1. List down the features and their types (e.g., numeric, nominal) available in the dataset.
2. Create a histogram for each feature in the dataset to illustrate the feature distributions.
3. Create a box plot for each feature in the dataset.
4. Compare distributions and identify outliers.

Group B: Big Data Analytics – JAVA/SCALA (Any three)

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 Map-Reduce framework on local-standalone set-up.
2. Design a distributed application using MapReduce which processes a log file of a system.
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.
4. Write a simple program in SCALA using Apache Spark framework

Group C- Mini Projects/ Case Study – PYTHON/R (Any TWO Mini Project)

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.
2. Use the following dataset and classify tweets into positive and negative tweets.
   https://www.kaggle.com/ruchi798/data-science-tweets
3. Develop a movie recommendation model using the scikit-learn library in python.
   Refer dataset
   https://github.com/rashida048/Some-NLP-Projects/blob/master/movie_dataset.csv
4. Use the following covid_vaccine_statewise.csv dataset and perform following analytics on the given dataset
   https://www.kaggle.com/sudalairajkumar/covid19-in-india?select=covid_vaccine_statewise.csv
   a. Describe the dataset
   b. Number of persons state wise vaccinated for first dose in India
   c. Number of persons state wise vaccinated for second dose in India
   d. Number of Males vaccinated
   e. Number of females vaccinated
5. Write a case study to process data driven for Digital Marketing **OR** Health care systems with Hadoop Ecosystem components as shown. (Mandatory)
   - HDFS: Hadoop Distributed File System
   - YARN: Yet Another Resource Negotiator
   - MapReduce: Programming based Data Processing
   - Spark: In-Memory data processing
   - PIG, HIVE: Query based processing of data services
   - HBase: NoSQL Database (Provides real-time reads and writes)
   - Mahout, Spark MLLib: (Provides analytical tools) Machine Learning algorithm libraries
   - Solr, Lucene: Searching and Indexing

Learning Resources

Reference Books :

1. Chirag Shah, "A Hands-On Introduction To Data Science", Cambridge University Press, 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 hauck, 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", OReilly 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

Web Links:

- https://www.simplilearn.com/data-science-vs-big-data-vs-data-analytics-article
- https://hadoop.apache.org/docs/current/hadoop-mapreduce-client/hadoop-mapreduce-client-core/MapReduceTutorial.html
- https://www.edureka.co/blog/hadoop-ecosystem
- https://www.edureka.co/blog/mapreduce-tutorial/#mapreduce_word_count_example
- https://github.com/[illegible]
- https://spark.apache.org/docs/latest/[illegible]
- https://www.scala-lang.org/

MOOC Courses link:

- https://nptel.ac.in/courses/106/106/106106212/
- https://onlinecourses.nptel.ac.in/noc21_cs45/preview
- https://nptel.ac.in/courses/106/104/106104189/
- https://onlinecourses.nptel.ac.in/noc20_cs92/preview

@The CO-PO Mapping Matrix

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

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

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

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 implementation 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 group of 2-3 students.

Suggested List of Laboratory Experiments/Assignments

(All assignments are compulsory)

<table>
<tr><th>Sr. No.</th><th>Assignment Title</th></tr>
<tr><td>1.</td><td>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:
<table>
<tr><th>Sr. No.</th><th>Website URL</th><th>Purpose of Website</th><th>Things liked in the website</th><th>Things disliked in the website</th><th>Overall evaluation of the website (Good/Bad)</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
From the evaluation, students should learn and conclude different website design issues, which should be considered while developing a website.</td></tr>
<tr><td>2.</td><td>Implement a web page index.htm for any client website (e.g., a restaurant website project) using following:
a. HTML syntax: heading tags, basic tags and attributes, frames, tables, images, lists, links for text and images, forms etc.
b. Use of Internal CSS, Inline CSS, External CSS</td></tr>
<tr><td>3.</td><td>Design the XML document to store the information of the employees of any business organization and demonstrate the use of:
a) DTD
b) XML Schema
And display the content in (e.g., tabular format) by using CSS/XSL.</td></tr>
<tr><td>4.</td><td>Implement an application in Java Script using following:
a) Design UI of application using HTML, CSS etc.
b) Include Java script validation
c) Use of prompt and alert window using Java Script

e.g., Design and implement a simple calculator using Java Script for operations like addition, multiplication, subtraction, division, square of number etc.
a) Design calculator interface like text field for input and output, buttons for numbers and operators etc.
b) Validate input values
c) Prompt/alerts for invalid values etc.</td></tr>
<tr><td>5.</td><td>Implement the sample program demonstrating the use of Servlet.

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.</td></tr>
<tr><td>6.</td><td>Implement the program demonstrating the use of JSP.

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.</td></tr>
<tr><td>7.</td><td>Build a dynamic web application using PHP and MySQL.

a. Create database tables in MySQL and create connection with PHP.
b. Create the add, update, delete and retrieve functions in the PHP web app interacting with MySQL database</td></tr>
</table>

8. Design a login page with entries for name, mobile number email id and login button. Use struts and perform following validations.
   a. Validation for correct names.
   b. Validation for mobile numbers.
   c. Validation for email id.
   d. Validation if no entered any value.
   e. Re-display for wrongly entered values with message.
   f. Congratulations and welcome page upon successful entries.

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. **Mini Project:** 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	1	1	-	1	1	-	-	1	-	-
CO2	2	3	-	2	1	-	-	-	1	-	-	-
CO3	3	-	3	-	-	1	-	-	-	1	1	-
CO4	[illegible]	2	2	1	2	1	[illegible]	-	-	-	-	1

Savitribai Phule Pune University
Third Year of Computer Engineering (2019 Course)
310258: Laboratory Practice II

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

Companion Course: Artificial Intelligence (310253), Elective II (310254)

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 a 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 interactive AI application
- **Information Security**
  - **CO4:** Use tools and techniques in the area of Information Security
  - **CO5:** Use the cryptographic techniques for problem solving
  - **CO6:** Design and develop security solution

OR

- **Augmented and Virtual Reality**
  - **CO4:** Use tools and techniques in the area of Augmented and Virtual Reality
  - **CO5:** Use the representing and rendering system for problem solving
  - **CO6:** Design and develop ARVR applications

OR

- **Cloud Computing**
  - **CO4:** Use tools and techniques in the area of Cloud Computing
  - **CO5:** Use cloud computing services for problem solving
  - **CO6:** Design and develop applications on cloud

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:** Design and develop applications using UML as fundamental tool

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.

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.
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.	Group A All assignments are compulsory
1.	Implement depth first search algorithm and Breadth First Search algorithm, Use an undirected graph and develop a recursive algorithm for searching all the vertices of a graph or tree data structure.
2.	Implement A star Algorithm for any game search problem.
3.	Implement Greedy search algorithm for any of the following application: I. Selection Sort II. Minimum Spanning Tree III. Single-Source Shortest Path Problem IV. Job Scheduling Problem V. Prim's Minimal Spanning Tree Algorithm VI. Kruskal's Minimal Spanning Tree Algorithm VII. Dijkstra's Minimal Spanning Tree Algorithm
	Group 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.

	Group C
C.	Implement any one of the following Expert System: i. Information management ii. Hospitals and medical facilities iii. Help desks management iv. Employee performance evaluation v. Stock market trading vi. Airline scheduling and cargo schedules

Part II : Elective II

Suggested List of Laboratory Experiments/Assignments

Sr. No.	Assignment Name
	Information Security **(Any five)**
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 different 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.
	Cloud Computing **(All assignments are compulsory)**
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. OR Case study on Amazon EC2 and learn about Amazon EC2 web services.
2.	Installation and configure Google App Engine. OR 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 Sales Force Cloud.
5.	**Mini-Project** 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 **with HDFS**. Implement the basic operations may be like to divide the file in segments/blocks and upload/ download file on/from cloud in encrypted form.
	Augmented and Virtual Reality **(Assignments 1,2, 3,7 are mandatory, any 2 from 4,5,6,8)**
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.	Develop a scene in Unity that includes:

i. A cube, plane and sphere, apply transformations on the 3 game objects.
ii. Add a video and audio source.

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/texture 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. Develop and deploy an AR app, implement the following using Vuforia Engine developer portal:
   i. Plane detection
   ii. Marker based Tracking(Create a database of objects to be tracked in Vuforia)
   iii. Object Tracking

7.

Mini-Projects/ Case Study

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.

OR

Create a treasure hunt AR application which should have the following features:
   i. A help button for instruction box to appear.
   ii. A series of markers which would give hints on being scanned.
   iii. Involve interaction, sound, and good UI.

Software Modeling and Architectures
(Problem statements 1, 2, 3 are mandatory and any one from 3 and 4)

1. 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.

2. Consider online shopping system. Perform the following tasks and draw the class diagram using UML tool.
Represent the individual classes, and objects
Add methods
Represent relationships and other classifiers like interfaces

3. Consider the online shopping system in the assignment 2.
Draw the sequence diagram using UML tool to show message exchanges

4. 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 canceling a flight ticket you can also cancel hotel booking. Appropriate refund as per policy is made in case of cancellation.
Perform the following tasks and draw the use case diagram using UML tool.
   a. Identify the use cases from a given non-trivial problem statement.
   b. Identify the primary and secondary actors for a system.
   c. Use to generalization of use cases and «include» stereotypes to prevent redundancy in the coding phase

Mini Project

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.

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 Modeling 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: [illegible]

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 Modeling and Architectures

1. Grady Booch, James Rambaugh, Ivar Jacobson, "The unified modeling language user guide", Pearson Education, Second edition, 2008, ISBN 0-321-24562-8.
2. Lan 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	PO1 0	PO1 1	PO12
CO1	3	-	3	-	3	-	-	3	3	2	1	3
CO2	1	-	2	2	1	2	-	2	3	2	1	2
CO3	1	-	3	3	3	3	-	3	3	3	2	3
CO4	1	-	2	-	1	-	-	2	2	2	2	2
CO5	1	-	2	-	1	-	-	3	2	3	2	3
CO6	1	-	2	-	1	-	-	2	2	2	2	2

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

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

Criteria

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

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

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

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

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

Audit Course 6 Options

Audit Course Code	Audit Course Title
310259A	Digital and Social Media Marketing
310259B	Sustainable Energy Systems
310259C	Leadership and Personality Development
310259D	Foreign Language (one of Japanese/Spanish/French/German). Course contents for **Japanese (Module 4)** are provided. For other languages institute may design suitably.
310259E	Learn New Skills - Software Development Using Agile Approach

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

Savitribai Phule Pune University
Third Year of Engineering (2019 Course)
Audit Course 6
310258(A): 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-[illegible]
2. Social Media Marketing Workbook (2021): How to Use Social Media for Business (2021 Social Media Marketing 1)

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Engineering (2019 Course)
Audit Course 6
310258(A): 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 Wizelius, "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	PO11	PO12
CO1	-	-	-	-	-	-	1	-	-	-	-	-
CO2	-	-	-	-	-	-	2	-	-	-	-	1
CO3	-	-	-	-	-	-	1	-	-	-	-	-
CO4	-	-	-	-	-	2	2	-	-	-	-	2

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

CO2: Develop effective team leadership abilities

CO3: Explore self-motivation and practicing creative/new age thinking

CO4: 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, Verbal and Channels, 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 communication, Patience and Clarity of Mind, Inspire and Motivate, Ensure Team Cohesion, Empathy, Trust and Belief etc.
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 Stereotypes, Application – Attitudinal Change and Reducing Prejudice, Self Esteem and Self Awareness, SWOT – SOAR, Self Esteem Quiz, Introduce Your Partner, Self Introduction - (how to sell yourself) appearance, voice modulation, verbal/nonverbal languages, 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", Himalaya Publication House
4. Baron R. Byrne D. Branscombe N. Bhardwaj G. (2009). "Social Psychology : Indian adaptation" , Pearson , New Delhi
5. Baumgardner 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
CO1	1	-	-	-	-	2	-	1	1	1	-	2
CO2	-	-	-	-	-	-	-	1	-	2	1	2
CO3	-	-	-	-	-	1	-	-	2	1	-	1
CO4	-	-	-	-	-	-	-	1	-	-	1	1

Savitribai Phule Pune University
Third Year of Engineering (2019 Course)
Audit Course 6
310258(B): Foreign Language (Japanese) Module 6

Prerequisites: It is recommended that candidates should have previously completed: AC3-IV (210251), AC4-V (214500) and AC5-IV (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 / Time travel related / Technical functions words)
6. More verb forms (te form, ta form, nai form, masu form 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 Textbook 1-1** (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)
3. Kanako Kanazawa, Makiko Koshiya, "Nihongo Challenge N4 N5 Kanji **Tanoshiku Kigoni**", 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
CO1	-	-	-	-	-	-	-	-	1	1	1	1
CO2	-	-	-	-	1	-	-	-	-	1	1	1
CO3	-	-	-	-	1	-	-	-	-	1	1	1
CO4	-	-	-	-	-	-	-	-	-	1	-	1

Savitribai Phule Pune University
Third Year of Engineering (2019 Course)
Audit Course 6
310258(E): Learn New Skills - "Software Development Using Agile Approach"

Prerequisites: Software Engineering (210253)

Course Objectives:

- To understand the fundamentals of Dev Ops
- 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 Dev Ops for the software product development

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

Course Contents

1. **THE THREE WAYS** : Agile, continuous delivery and the three ways, The First Way: The Principles of Flow, The Second Way: The Principles of Feedback, The Third Way: The Principles of Continual Learning
2. **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.
3. **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.
4. **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 operations 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.
5. **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 :

1. Gene Kim, Jez Humble, Patrick Debois, "The Dev Ops Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations"
2. Len Bass, Ingo Weber, Liming Zhu, "Dev Ops: A Software Architect's Perspective", Publisher(s): Addison-Wesley Professional, ISBN: 9780134049847

Note: This is sample contents for Software Development Using Agility Approach, however the course instructor may design suitable course giving opportunity to the students for learning new skills.

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO1	1	1	2	1	1	1	-	1	-	1	-	-
CO2	-	1	1	2	1	-	-	-	1	1	-	1
CO3	2	1	1	1	-	1	1	-	-	-	-	1
CO4	2	1	1	1	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 unstated 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 parameters as per AICTE guidelines and to make the graduates competent enough so 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 through coordination, 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 current situation, during the time of this unfortunate pandemic, each and every person, including the course coordinators and their team members, have worked assiduously 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 management of various colleges affiliated to SPPU for helping us in this work. These colleges have helped us by arranging sessions for preliminary discussions 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 entirely 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 the draft. I would like to thank you from the core of my heart. Thank you for always being your best selves and contributing to the work.

I am thankful to 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, and
Members, Dr. Shirish Sane, Dr. Sunil Bhirud, Dr. Manik Dhore, Dr. Pramod Patil, Dr. Girish Khilari, Dr. Sachin Lodha, Dr. Parikshit Mahalle, Dr. [illegible], Dr. [illegible] Kale, Dr. Bahubali Shiragapur, Dr. B. S. Patil and Dr. P. M. Yawalkar

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

Task Force at Curriculum Design

1. **Advisors, the Team of Board of Studies-**

Dr. Varsha Patil (Chairman), Dr. Shashi Sane, Dr. Sunil Bhirud, Dr. Manik Dhore, Dr. Pramod Patil, Dr. Rupesh Prasad, Dr. Girish Khilari, Dr. Sachin Lodha, Dr. Parikshit Mahalle, Mr. Venkatesham, Dr. Ganapati Kale, Dr. Bahubali Hiae, Dr. B. V. Patil and Dr. P. M. Yawalkar.

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	
Database Management Systems	Dr. Amitkumar Thakare	Dr. Sarika Bobde Zawar Dr. S. R. Tandle Prof. Ranjit M. Gawande	Prof. Rahul Patil Prof. Prashant Ahire Dr. Sharmila Wagh
Theory of Computation	Dr. Sunil Dhore	Dr. Santosh Darade Dr. Jyoti Rao Dr. S. R. Bhosale Mr. Tushar Sawarkar (Industry)	Dr. Vaishali Tidake Prof. Anita Shinde Mr. Vivek Kulkarni (Industry)
Systems Programming and Operating Systems	Dr. Shantanu Bhosale	Dr. B. A. Sonkamble Prof. Rupesh Mahajan Prof. Mrs K.Mahalakshmi Prof. Mrs. Rashmi Patil	Dr. V. S. Pawar Prof. S. R. Pande Prof. Mrs. Dhanashree Patil
Computer Networks and Security	Dr. P. B. Kumbharkar	Dr. Aparna A. Junnarkar Dr. A. V. Dhumane Dr. Vinod V. Kimbahune	Prof. B. R. Gaikwad Dr. M. L. Dhore
Elective I: Internet of Things and Embedded Systems	Dr. A. B. Pawar	Dr. Sandeep Chavan Dr. M. S. Chaudhari Dr. M. P. Wankhade	Mr. Rajesh Kamble (Industry) Mr. Mahesh Adsul (Industry)
Elective I: Human Computer Interface	Dr. S. D. Babar	Prof. Mrs. D. S. Dhupal Prof. R. O. Sagdal Prof. Mrs.Jayashree R. Pansare Mr. Mahesh Jain (Industry) Prof. Mrs. Shailaja V. Lohar	Prof. S. A. Thakekar Dr. Deepak Dharne Dr. Ganesh Bhutkar Mr. Hemant Sarjikar (Industry)
Elective I: Distributed System	Dr. Anant Nimkar	Prof. Rupesh Kharat Dr. Sandip V. Shelkar Mr. Pravin Deva (Industry)	Dr. Swati A. Bhavsar Dr. Sonali Patil Dr. Harsha Shinde Mr. Vijay Bahirat (Industry)
Elective I: Software Project Management	Dr. Rachna Sable	Dr. K. L. Patkar Prof. Santosh Sambare Prof. Pangudkar S.P.	Prof. Manish Rathod Prof. Mrs. Vaishali M. Kolhe Mr. Prashant Patel (Industry) Mr. Shekhar Dhapkar (Industry)
Database Management System Laboratory	Prof. Rahul Patil	Prof. Rupesh Kharat	Vijay Dhakage (Industry)
Computer Networks and Security Laboratory	Dr. Vinod V. Kimbahune	Dr. P. B. Kumbharkar Dr. Aparna A. Junnarkar Dr. A. V. Dhumane	Prof. B. R. Gaikwad Dr. M. L. Dhore
Laboratory Practice I	Dr. Amol Potgantwar	Dr. Manisha Bhende Dr. M.P. Wankhade Mrs. Shailaja V. Lohar	Dr. Sonali Patil Prof. Santosh Sambare
Seminar	Dr. Swati A. Bhavsar	Mr. Rushikesh Jadhav (Industry) Mr. Krishna Kant (Industry)	Dr. (Mrs.) Pradnya P. Shaikh Mr. Ranjit M. Gawande

Audit Course 5	Dr. Kishor Wagh	Dr. S. S. Das Dr. D. V. Patil	Dr. Sandeep Patil Dr. [illegible] Mr. [illegible]
Data Science and Big Data Analytics	Dr. Sheetal Sonawane	Dr. H. K. Khanuja Prof. Devidas S. Thosar Dr. S.K. Shinde Mr. Anand Bhalerao (Industry) Mr. Sumit Vaidya (Industry)	Dr. M. U. [illegible] Dr. K. V. Metre Mr. Atul [illegible] (Industry) Mr. [illegible] Patil (Industry) Mr. [illegible] Kumar (Industry)
Web Technology	Prof. Abhijit D. Jadhav	Prof. [illegible]	Mr. Avinash Patil (Industry) Mr. [illegible] (Industry)
Artificial Intelligence	Dr. [illegible] Prasad	Dr. [illegible] Dr. V. P. Vikhe Dr. Sachin Mohan Kanadkhedkar	Dr. R. Rajeswari Dr. Mrs. Madhavi Pradhan
Elective II: Information Security	Dr. Swati Nikam	Dr Pathan Mohd Shafi Dr Mininath [illegible] Dr. Mrs. K.C. Nalavade	Dr. [illegible] Dr. Amol Potgantwar Mr. Akshay [illegible] (Industry)
Elective II: Augmented and Virtual Reality	Dr. [illegible] Shukla	Prof. Sagar [illegible] Prof. Dinesh Ashok Kagade	Prof. Sanjay Agrawal Prof. [illegible] Mr. [illegible] (Industry) Mr. [illegible] (Industry)
Elective II: Cloud Computing	Dr. S. R. [illegible]	Prof. Abhijit D. Jadhav Dr. Pankaj Agarkar Dr. N. M. Ranjan	Dr. A. S. [illegible] Prof. [illegible] R. H. Mr. Ashish Pawar (Industry) Mr. Santosh [illegible] (Industry)
Elective II: Software Modeling and Architectures	Dr M A Pradhan	Prof. Mrs. Dipalee Dinkar Rane Prof. Jyoti Gaikwad	Dr. [illegible] Deshpande Prof. [illegible] Dr. [illegible]
Internship	Dr. [illegible] V. Kale	Mr. Amit Kulkarni (Industry) Mr. Nilesh Deshmukh (Industry) Prof. Pradnya Kulkarni	Prof. Dhiraj Agrawal Prof. [illegible]
Data Science and Big Data Analytics Laboratory	Dr. H. K. Khanuja	Dr. Sheetal Sonawane Prof. Devidas S. Thosar Dr. S.K. Shinde Mr. Anand Bhalerao (Industry) Mr. Sumit Vaidya (Industry)	Dr. M. U. [illegible] Dr. K. V. Metre Mr. Atul [illegible] (Industry) Mr. [illegible] Patil (Industry) Mr. [illegible] Kumar (Industry)
Web Technology Laboratory	Prof. Abhijit D. Jadhav	Mr. Avinash Patil (Industry)	Mr. [illegible] (Industry)
Laboratory Practice III	Dr. Sachin Mohan Kanadkhedkar	Dr. R. Rajeswari Dr Pathan Mohd Shafi Dr. Shaikh [illegible]	Dr. N. M. Ranjan Dr M A Pradhan
Audit Course 6	Dr. [illegible]	Dr. S. S. Das	Prof. Abhijit D. Jadhav

Back to Table of Contents