

Savitribai Phule Pune University Maharashtra, India

Faculty of Science and Technology



Curriculum for

Third Year of Computer Science

(2019 Course)



(With effect from 2025-26)

Third Year of Computer Science (2019 Course)

Prefare by Board of Studies

Dear Students and Teachers,

We, the members of Board of Studies Computer Engineering, are very happy to present Third Year Computer Science syllabus effective from the Academic Year 2025-26. Subsequently this will be carried forward for BE in AY 2026-27. Computer science is an interdisciplinary field of engineering that uses scientific methods, processes, algorithms, and systems to extract knowledge and insights from structured and unstructured data. It has gained a lot of attention in last decade.

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

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

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



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

Savitribai Phule Pune University
Third Year of Computer Science (2019 Course)
 (With effect from Academic Year 2025-26)

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Note: *: These are the subjects **common** with TE Computer Engineering

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

Learners are expected to know and be able to

PO1	Engineering knowledge	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems.
PO2	Problem analysis	Identify, formulate, review research literature and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and Engineering sciences.
PO3	Design / Development of Solutions	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations.
PO4	Conduct Investigations of Complex Problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern Tool Usage	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.
PO6	The Engineer and Society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and Sustainability	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of 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 Science Program will demonstrate-

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

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Third Year of Computer Science (2019 Course)															
(With effect from Academic Year 2025-26)															
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	
310544	TCP/IP Networking	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	
310547	TCP/IP Networking Laboratory	-	02	-	-	-	25	-	25	50	-	01	-	01	
310548	Laboratory Practice III	-	04	-	-	-	25	25	-	50	-	02	-	02	
310249*	Seminar and Technical Communication	-	01	-	-	-	50	-	-	50	-	01	-	01	
Total		15	11	-	150	350	125	50	25	700	15	06	-	21	
310250*	Audit Course 5											Grade			
Total Credit											15	06	-	21	
Elective I						Audit Course 5									
<ul style="list-style-type: none">Internet of Things and Embedded SystemsHuman Computer InterfaceDistributed SystemsSoftware Project Management						<ul style="list-style-type: none">Cyber SecurityProfessional Ethics and EtiquettesMOOC- Learn New SkillsEngineering EconomicsForeign Language									
Laboratory Practice III															
Assignments from Systems Programming and Operating System and Elective I															
Note: * : These are the subjects common with TE Computer Engineering															

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Third Year of Computer Science (2019 Course)															
(With effect from Academic Year 2025-26)															
Semester VI															
Course Code	Course Name	Teaching Scheme (Hours/ week)			Examination Scheme and Marks						Credit Scheme				
		Lecture	Practical	Tutorial	Mid-Sem	End-Sem	Term work	Practical	Oral	Total	Lecture	Practical	Tutorial	Total	
310251*	Data Science and Big Data Analytics	03	-	-	30	70	-	-	-	100	03	-	-	03	
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**	-	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	
310558	Laboratory Practice IV	-	04	-	-	-	50	25	-	75	-	02	-	02	
Total											12	09	-	21	
Total		12	10	-	120	280	225	50	25	700	12	05	-	21	
310259*	Audit Course 6												Grade		
Elective II <ul style="list-style-type: none">Information SecurityAdvanced TCP/IPCloud ComputingSoftware Modeling and Architectures					Audit Course 6 <ul style="list-style-type: none">Digital and Social Media MarketingSustainable Energy SystemsLeadership and Personality DevelopmentForeign LanguageMOOC- Learn New Skills										
Laboratory Practice IV: Assignments from Artificial Intelligence and Elective II.															
** Internship: Internship guidelines are provided in course curriculum sheet.															
Note: *: These are the subjects common with TE Computer Engineering															

General Guidelines

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

It is recommended to conduct internal monthly practical examination as part of continuous assessment.

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

- 10. Laboratory Journal-** Program codes with sample output of all performed assignments are to be submitted as softcopy. Use of DVD or similar media containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Submission of journal/ term work in the form of softcopy is desirable and appreciated.

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

- 12. Audit Course** ^[1] The student registered for audit course shall be awarded the grade AP/PP (Audit Course Pass) and the grade 'AP'/'PP' shall be included in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory performance and secured a passing grade in that audit course. No grade points are associated with this 'AP'/'PP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself.
- 13. UGC** has issued the UGC (Credit Framework for online learning courses through SWAYAM) Regulation 2016 advising the Universities to identify courses where credits can be transferred on to the academic record of the students for courses done on SWAYAM. AICTE has also put out gazette notification in 2016 and subsequently for adoption of these courses for credit transfer ^[2].

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

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

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

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

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

Curriculum for Third Year of Computer Science (2019 Course)



Semester V

(With effect from 2025-26)

Savitribai Phule Pune University		
Third Year of Computer Science (2019 Course)		
310241: Database Management Systems		
Teaching Scheme: TH: 03 Hours/Week	Credit: 03	Examination Scheme: Mid-Sem (TH) : 30 Marks End-Sem (TH): 70 Marks
Prerequisites Courses: Discrete Mathematics (210241), Data Structures and Algorithms (210252)		
Companion Course: Database Management Systems Laboratory (310246)		
Course Objectives: <ul style="list-style-type: none">To understand the fundamental concepts of Database Management SystemsTo acquire the knowledge of database query languages and transaction processingTo understand systematic database design approachesTo acquire the skills to use a powerful, flexible, and scalable general-purpose databases to handle Big DataTo be familiar with advances in databases and applications		
Course Outcomes: <p>On completion of the course, learners should be able to</p> <p>CO1: Analyze and design Database Management System using ER model</p> <p>CO2: Implement database queries using database languages</p> <p>CO3: Normalize the database design using normal forms</p> <p>CO4: Apply Transaction Management concepts in real-time situations</p> <p>CO5: Use NoSQL databases for processing unstructured data</p> <p>CO6: Differentiate between Complex Data Types and analyze the use of appropriate data types</p>		
Course Contents		
Unit I	Introduction to Database Management Systems and ER Model	06 Hours
Introduction, Purpose of Database Systems, Database-System Applications, View of Data, Database Languages, Database System Structure, Data Models. Database Design and ER Model: Entity, Attributes, Relationships, Constraints, Keys, Design Process, Entity-Relationship Model, ER Diagram, Design Issues, Extended E-R Features, converting ER and EER diagram into tables.		
#Exemplar/Case Studies	Analyze and design database using ER Model for any real-time application and convert the same into tables.	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	SQL and PL/SQL	07 Hours
SQL: Characteristics and Advantages, SQL Data Types and Literals, DDL, DML, DCL, TCL, SQL Operators. Tables: Creating, Modifying, Deleting, Updating. SQL DML Queries: SELECT Query and clauses, Index and Sequence in SQL. Views: Creating, Dropping, Updating using Indexes, Set Operations, Predicates and Joins, Set membership, Tuple Variables, Set comparison, Ordering of Tuples, Aggregate Functions, SQL Functions, Nested Queries. PL/SQL: Concept of Stored Procedures and Functions, Cursors, Triggers, Assertions, Roles and Privileges.		
#Exemplar/Case Studies	Implementation of Unit 1 case study using SQL and PL/SQL.	
*Mapping of Course Outcomes for Unit II	CO1, CO2	

Unit III	Relational Database Design	06 Hours
Relational Model: Basic concepts, Attributes and Domains, CODD's Rules. Relational Integrity: Domain, Referential Integrities, Enterprise Constraints. Database Design: Features of Good Relational Designs, Normalization, Atomic Domains and First Normal Form, Decomposition using Functional Dependencies, Algorithms for Decomposition, 2NF, 3NF, BCNF.		
#Exemplar/Case Studies	Normalize relational database designed in Unit I.	
*Mapping of Course Outcomes for Unit III	CO1, CO3	
Unit IV	Database Transaction Management	07 Hours
Introduction to Database Transaction, Transaction states, ACID properties, Concept of Schedule, Serial Schedule. Serializability: Conflict and View, Cascaded Aborts, Recoverable and Non-recoverable Schedules. Concurrency Control: Lock-based, Time-stamp based Deadlock handling. Recovery methods: Shadow-Paging and Log-Based Recovery, Checkpoints. Log-Based Recovery: Deferred Database Modifications and Immediate Database Modifications.		
#Exemplar/Case Studies	Study of Transaction Management in 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 databases for processing unstructured data from social media.	
*Mapping of Course Outcomes for Unit V	CO5, CO6	
Unit VI	Advances in Databases	07 Hours
Emerging Databases: Active and Deductive Databases, Main Memory Databases, Semantic Databases. Complex Data Types: Semi-Structured Data, Features of Semi-Structured Data Models. Nested Data Types: JSON, XML. Object Orientation: Object-Relational Database System, Table Inheritance, Object-Relational Mapping. Spatial Data: Geographic Data, Geometric Data.		
#Exemplar/Case Studies	Applications of advanced databases in real time environment.	
*Mapping of Course Outcomes for Unit VI	CO5, CO6	

Learning Resources

Text Books :

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

Reference Books :

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

e-Books :

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

MOOCs Courses Links:

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University Third Year of Computer Science (2019 Course) 310242: Theory of Computation		
Teaching Scheme: TH: 03 Hours/Week	Credit: 03	Examination Scheme: Mid-Sem (TH) : 30 Marks End-Sem (TH): 70 Marks
Prerequisites Courses: Discrete Mathematics (210241)		
Companion Course: --		
Course Objectives: <ul style="list-style-type: none"> To introduce the students to basics of Theory of Computation To study abstract computing models to provide a formal connection between algorithmic problem solving and the theory of languages To learn Grammar, Pushdown Automata and Turing Machine for language processing and algorithm design To learn about the theory of computability and complexity for algorithm design 		
Course Outcomes: After completion of the course, learners should be able to CO1: Understand formal language, translation logic, essentials of translation, alphabets, language representation and apply it to design Finite Automata and its variants CO2: Construct regular expression to present regular language and understand pumping lemma for RE CO3: Design Context Free Grammars and learn to simplify the grammar CO4: Construct Pushdown Automaton model for the Context Free Language CO5: Design Turing Machine for the different requirements outlined by theoretical computer science CO6: Understand different classes of problems, classify and analyze them and study concepts of NP completeness		
Course Contents		
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 inter-conversion. Minimization of DFAs. FA with output: Moore and Mealy machines -Definition, models, inter-conversion.		
#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 NFA, DFA, DFA to RE using Arden's theorem, Pumping Lemma for Regular languages, Closure and Decision properties of Regular languages. Myhill-Nerode theorem.		

#Exemplar/Case Studies	RE in text search and replace	
*Mapping of Course Outcomes for Unit II	CO2	
Unit III	Context Free Grammar (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, 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 Machines (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 Machines, Halting Problem of TM, Halting vs Looping, A Turing-unrecognizable language, Reducibility, Recursion Theorem. The Model of Linear Bounded Automata.		
#Exemplar/Case Studies	Algorithms using Turing Machine	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	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. 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 hard Problems.		
#Exemplar/Case Studies	Traveling salesman problem, Post Correspondence Problem (PCP)	
*Mapping of Course Outcomes for Unit VI	CO6	

Learning Resources

Text Books:

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

Reference Books:

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

e-Books :

- <https://cglab.ca/~michiell/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](http://ce.sharif.edu/courses/94-95/1/ce414-2/resources/root/Text%20Books/Automata/John%20E.%20Hopcroft,%20Rajeev%20Motwani,%20Jeffrey%20D.%20Ullman-Introduction%20to%20Automata%20Theory,%20Languages,%20and%20Computations-Prentice%20Hall%20(2006).pdf)

MOOCs Courses Links:

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University

Third Year of Computer Science (2019 Course)

310243: Systems Programming and Operating System


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

Prerequisites Courses: Programming and Problem solving (110005), Data Structures and Algorithms (210252), Principles of Programming Languages (210255), Microprocessor (210254)

Companion Course: Laboratory Practice III (310548)

Course Objectives:

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

Course Outcomes:

On completion of the course, learners should be able to

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

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

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

CO4: Implement and Analyze the performance of process scheduling algorithms

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

CO6: Demonstrate memory organization and memory management policies

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

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

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

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

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

#Exemplar/Case Studies

Study of Debugging tools like GDB

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

CO1, CO2, CO3

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

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

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

#Exemplar/Case Studies	GNU M4 Macro Processor	
*Mapping of Course Outcomes for Unit II	CO1, CO2, CO3	
Unit III	Linkers and Loaders	07 Hours
Introduction, 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	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: Uni-processor 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/Producer Consumer problem/Dining Philosopher problem.	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Synchronization and Concurrency Control	07 Hours
Concurrency: principle and issues with concurrency, Mutual Exclusion, Hardware approach, Software approach, Semaphore, Mutex and monitor, Reader writer problem, producer Consumer problem, Dining Philosopher problem. Deadlocks: Principle of deadlock, Deadlock prevention, deadlock avoidance, deadlock detection, deadlock recovery.		
#Exemplar/Case Studies	Concurrency Mechanism: Unix/Linux/Windows.	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Memory Management	07 Hours
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, “System Programming”, McGraw Hill, ISBN 978-0--07-460482-3.
2. Dhamdhare 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 81-7366-062-X.
3. Alfred V. Aho, Ravi Sethi, Reffrey D. Ullman, “Compilers Principles, Techniques, and Tools”, Addison Wesley, ISBN 981-235-885-4

e-Books :

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

MOOCs Courses Links:

- <https://www.udacity.com/course/introduction-to-operating-systems--ud923>
- Nptel video lecture link: <https://nptel.ac.in/courses/106/105/106105214/>
- <https://www.edx.org/course/computer-hardware-and-operating-systems>
- https://onlinecourses.nptel.ac.in/noc19_cs50/preview
- <https://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 Science (2019 Course) 310544: TCP/IP Networking		
Teaching Scheme: TH: 03 Hours/Week	Credit: 03	Examination Scheme: Mid-Sem (TH) : 30 Marks End-Sem (TH): 70 Marks
Prerequisites Courses: --		
Companion Course: TCP/IP Networking Laboratory (310547)		
Course Objectives: <ul style="list-style-type: none"> To learn the fundamentals of TCP/IP protocol suit. To learn the basics of Internet and its working. To learn services and protocols used at different layers of TCP/IP protocol stacks. To learn the fundamental concepts of Information Security. 		
Course Outcomes: On completion of the course, learners should be able to CO1: Summarize fundamental concepts of Computer Networks, Internet and application layer protocols. CO2: Illustrate services and protocols used at transport layer. CO3: Analyze the working of different routing protocols and mechanisms. CO4: Illustrate the working and functions of link layer and LAN. CO5: Analyze IEEE standards of Wireless and Mobile Networks. CO6: Comprehend the basics of Network Security.		
Course Contents		
Unit I	Computer Networks, Internet And Application Layer	07 Hours
Introduction to computer networks and Internet: Understanding of network and Internet, The network edge, the network core, Delay, Loss and Throughput in the packet switching network, protocols layers and their service model, History of the computer network Application Layer: Principles of computer applications, Web and HTTP, E-mail, DNS, Socket programming with TCP and UDP, DHCP		
#Exemplar/Case Studies	Study of Application Layer protocols using network protocol analyzer. e.g. Wireshark	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Transport Layer	07 Hours
Introduction and transport layer services, Multiplexing and Demultiplexing, Connectionless transport (UDP), Principles of reliable data transfer, Connection-oriented transport (TCP), Congestion control, TCP congestion control		
#Exemplar/Case Studies	Demonstration of Transport layer protocols on Simulator.	
*Mapping of Course Outcomes for Unit II	CO2	

Unit III	Network Layer	06 Hours
Introduction to forwarding and routing, Network Service models, Virtual and Datagram networks, study of router, IP protocol and addressing in the Internet, Routing algorithms, Broadcast and Multicast routing		
Introduction: Functions of Network layer. 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.		
#Exemplar/Case Studies	Demonstration of Routing Protocols on simulator	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Link Layer And Local Area Networks	06 Hours
Introduction to link layer services, error-detection and correction techniques, Error detection and correction, Parity Bits, Hamming Codes (11/12-bits) and CRC, Multiple access protocols, Multiple Access Protocols: Pure and Slotted ALOHA, CSMA, WDMA, CSMA/CD, CSMA/CA, addressing, Ethernet, switches, VLAN		
#Exemplar/Case Studies	Study of Campus wide networking.	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Wireless and Mobile Networks	07 Hours
Introduction, Wireless Links and Network Characteristics, CDMA, WiFi: 802.11 Wireless LANs: The 802.11 Architecture, The 802.11 MAC Protocol, The IEEE 802.11 Frame, Mobility in the Same IP Subnet, Advanced Features in 802.11, Personal Area Networks: Bluetooth and Zigbee, Cellular Internet Access: An Overview of Cellular Network Architecture, 3G Cellular Data Networks: Extending the Internet to Cellular Subscribers, On to 4G: LTE, Mobility Management: Principles, Addressing, Routing to a Mobile Node, Mobile IP, Managing Mobility in Cellular Networks, Routing Calls to a Mobile User, Handoffs in GSM, Wireless and Mobility: Impact on Higher-Layer Protocols		
#Exemplar/Case Studies	Study of WiFi setup in college/campus.	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Security in Computer Networks	07 Hours
Network Security, Principles of Cryptography, Symmetric Key Cryptography, Public Key Encryption, Message Integrity and Digital Signatures, Cryptographic Hash Functions, Message Authentication Code, Digital Signatures, End-Point Authentication, Authentication Protocol ap1.0, Authentication Protocol ap2.0, Authentication Protocol ap3.0, Authentication Protocol ap3.1, Authentication Protocol ap4.0, Authentication Protocol ap1.0,2.0,3.0,3.1,4.0. Securing E-Mail, Secure E-Mail, PGP, Securing TCP Connections: SSL, The Big Picture, A More Complete Picture, Network-Layer Security: IPsec and Virtual Private Networks, IPsec and Virtual Private Networks (VPNs), The AH and ESP Protocols, Security Associations, The IPsec Datagram, IKE: Key Management in IPsec, Securing Wireless LANs, Wired Equivalent Privacy (WEP), IEEE 802.11i, Operational Security: Firewalls and Intrusion Detection Systems, Firewalls, Intrusion Detection Systems		
#Exemplar/Case Studies	Study of security protocols in Network, Transport and Application Layer using network protocol analyzer. e.g. Wireshark	

*Mapping of Course Outcomes for Unit VI	CO6
Learning Resources	
Text Books :	
1. Kurose Ross, Computer Networking: A Top Down Approach Featuring the Internet, Pearson Education, ISBN: 978-81-7758-878-1.	
Reference Books :	
1. Andrew S. Tanenbaum, David J. Wethrall, Computer Network, Pearson Education, ISBN: 978-0-13-212695-3 2. Behrouz A. Forouzan, TCP/IP Protocol Suite, McGraw Hill Education, ISBN: 978-0-07-070652-1, 4th Edition 3. Behrouz A. Forouzan, Data Communication and Networking, McGraw Hill Education, ISBN: 978-1-25-906475-3, 5th Edition 4. Mayank Dave, Computer Network, Cengage Learning, ISBN: 978-81-315-0986-9 5. L. Peterson and B. Davie, "Computer Networks: A Systems Approach", 5th Edition, Morgan-Kaufmann, 2012. 6. Douglas E. Comer & M.S Narayanan, "Computer Network & Internet", Pearson Education 7. William Stallings, "Cryptography and Network Security: Principles and Practice", 4th Edition	
e-Books :	
<ul style="list-style-type: none"> https://people.cs.clemson.edu/~jmarty/courses/kurose/KuroseCh1-2.pdf http://eti2506.elimu.net/Introduction/Books/Data Communications and Networking By Behrouz A.Forouzan.pdf http://intronetworks.cs.luc.edu/current/ComputerNetworks.pdf https://www.tutorialspoint.com/data_communication_computer_network/data_communication_on_computer_network_tutorial.pdf 	
Case Study:	
<ul style="list-style-type: none"> https://slideplayer.com/slide/6106945 http://www.worldcolleges.info/sites/default/files/Cisco - Ccie Fundamental - Network Design And Case Studies.PDF http://vlabs.iitb.ac.in/vlabs-dev/labs_local/computer-networks/labs/explist.php 	
MOOCs Courses link:	
<ul style="list-style-type: none"> nptel.ac.in/courses/106/105/106105183 nptel.ac.in/courses/106/105/106105080 nptel.ac.in/courses/106/105/106105081 nptel.ac.in/courses/106/106/106106091 nptel.ac.in/courses/106/105/106105031 https://www.mooc-list.com/tags/computer-networking https://www.coursera.org/courses?query=computer%20network 	

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

Savitribai Phule Pune University
Third Year of Computer Science (2019 Course)



Elective I
310245(A): Internet of Things and Embedded Systems

Teaching Scheme: TH: 03 Hours/Week	Credit: 03	Examination Scheme: Mid-Sem (TH) : 30 Marks End-Sem (TH): 70 Marks
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Prerequisites Courses: TCP/IP Networking (310544)

Companion Course: Laboratory Practice III (310548)

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 in 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, Four pillars 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	CO4,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 Service, 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: 978-1-119-99435-0		
Reference Books:		
1. Dawoud Shenouda Dawoud, Peter Dawoud, “Microcontroller and Smart Home Networks”, ISBN: 9788770221566, e-ISBN: 9788770221559		
2. Charles Crowell, “IoT-Internet of Things for Beginners: An Easy-to-Understand Introduction to IoT”,ISBN-13 : 979-8613100194		
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 numbers, source ISBN : 1540335011.
5. Brian Russell, Drew Van Duren, “Practical Internet of Things Security”, Second Edition, Packt Publishing, ISBN: 9781788625821

e-Books :

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

MOOCs Courses link

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University

Third Year of Computer Science (2019 Course)

Elective I

310245(B): Human Computer Interface

Home

Teaching Scheme: TH: 03 Hours/Week	Credit: 03	Examination Scheme: Mid-Sem (TH) : 30 Marks End-Sem (TH): 70 Marks
Prerequisites Courses: Computer Graphics (210244), Software Engineering (210253)		
Companion Course: Laboratory Practice III (310548)		
Course Objectives: <ul style="list-style-type: none"> To understand the importance of HCI design process in software development To learn fundamental aspects of designing and implementing user interfaces To study HCI with technical, cognitive and functional perspectives To acquire knowledge about variety of effective human-computer-interactions To co-evaluate the technology with respect to adapting changing user requirements in interacting with computer 		
Course Outcomes: <p>On completion of the course, learners should be able to</p> <p>CO1: To design effective Human-Computer-Interfaces for all kinds of users</p> <p>CO2: To apply and analyze the user-interface with respect to golden rules of interface</p> <p>CO3: To analyze and evaluate the effectiveness of a user-interface design</p> <p>CO4: To implement the interactive designs for feasible data search and retrieval</p> <p>CO5: To analyze the scope of HCI in various paradigms like ubiquitous computing, virtual reality ,multi-media, World wide web related environments</p> <p>CO6: To analyze and identify user models, user support, and stakeholder requirements of HCI systems</p>		
Course Contents		
Unit I	Introduction and Foundation of HCI	07 Hours
<p>Foundation: Human Memory. Thinking: reasoning and problem solving, Emotion, Individual Difference, Psychology and design of Interactive systems, The Computer-Text Entry Device, Positioning, Pointing, Display devices, Devices for virtual reality and 3D Interaction, The Interactions-Models of Interaction, Frameworks and HCI, Ergonomics, Interaction styles, Ergonomics, Elements of WIMP Interface, Interactivity, Measurable Human Factors, The context of Interaction. Importance of User Interface: Defining user Interface, Brief History of Human-Computer Interface, Good and Poor Design- Importance of good design.</p>		
#Exemplar/Case Studies	Paper prototype – Design elements of GUI	
*Mapping of Course Outcomes for Unit I	CO1,CO6	
Unit II	Human Perspective in Interaction Design Process	07 Hours
<p>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</p>		

interaction style, Natural Language, Eight Golden rules of Interface design, Prevent errors, Ensuring Human control while increasing automation. Theories: Design-by-level, Stages of action, Consistency, Contextual Theories, Dynamic theories.		
#Exemplar/Case Studies	Registration form design.	
*Mapping of Course Outcomes for Unit II	CO1,CO2	
Unit III	Interaction Styles and HCI in Software Process	07 Hours
Design, Process of Interaction Design. Interaction styles: Command line, Menu Selection, Form fill-in, Direct Manipulation. Graphical User Interface: Popularity of Graphics, Concept of direct manipulation, Advantages, Disadvantages and characteristics of Graphical user interface. Web User Interface: Popularity and Characteristics, Merging of Graphical business systems and the Web-Characteristics of Intranet versus Internet, Web page versus application design, Principles for user interface design, Software life cycle, Usability Engineering, Iterative design and prototyping, Design Rationale.		
#Exemplar/Case Studies	Comparison - GUI and Web design with a real time example.	
*Mapping of Course Outcomes for Unit III	CO1,CO3,CO5	
Unit IV	Usability Evaluation and Universal Design	07 Hours
User interface design process: Designing for People: Seven commandments, Usability Assessment in the Design process, Common Usability problems, Practical and Objective measures of Usability, Formative and Summative evaluation, Usability specifications for evaluation, Analytic methods, Model based analysis, GOMS model, Empirical methods, Field studies, Usability testing in Laboratory, Controlled experiments, Heuristic Evaluation, Cognitive Walkthrough. Evaluation framework: Paradigms and techniques, DECIDE: a framework to guide evaluation, Universal design principles, Multi-modal interaction, Designing for diversity.		
#Exemplar/Case Studies	GOMS model - Adding items to a cart of e-shopping website.	
*Mapping of Course Outcomes for Unit IV	CO1,CO3	
Unit V	HCI Paradigms	07 Hours
Paradigms for Interaction: Time sharing, Video display units, Programming toolkits, Personal computing, The metaphor, Direct manipulation, Hypertext, Computer-supported cooperative work, Agent based interfaces. Ubiquitous Computing: Sensor-based and context-aware interaction, Data Integrity versus Data immunity, Handling missing data, Data entry and fudgeability, Auditing versus Editing, Retrieval in Physical World, Retrieval in Digital world, Constrained Natural Language output, Five stage search framework, Dynamic queries and faceted search, The social aspects of search. Pattern Recognition: Introduction, Examples, Role of Machine Learning, Pattern Recognition Process, Pattern Recognition in HCI.		
#Exemplar/Case Studies	Interface Design- Pattern gesture recognition	
*Mapping of Course Outcomes for Unit V	CO1,CO3,CO4	
Unit VI	HCI for Mobile and Handheld devices	07 Hours
Designing for Mobile and other devices: Anatomy of a Mobile app, Mobile form factors, Handheld		

format apps, Tablet format apps, Mini-tablet format apps, Mobile Navigation, Content, and control idioms- browse controls, Navigation and toolbars, Drawers, Tap-to-reveal and direct manipulation, Searching, Sorting and Filtering, Welcome and help screens, Multi-touch gestures, Inter-app integration, Android Accessibility Guidelines.

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

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

Learning Resources

Text Books:

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

Reference Books :

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

e-Books :

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

MOOCs Courses link

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University Third Year of Computer Science (2019 Course) Elective I 310245(C): Distributed Systems		
Teaching Scheme: TH: 03 Hours/Week	Credit: 03	Examination Scheme: Mid-Sem (TH) : 30 Marks End-Sem (TH): 70 Marks
Prerequisites Courses: TCP/IP Networking(310544)		
Companion Course: Laboratory Practice III (310548)		
Course Objectives: <ul style="list-style-type: none"> 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 Outcomes for Unit II	CO2	
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 Contribution: Aggregation, A Peer-Sampling Service, Gossip-Based Overlay Construction.		
#Exemplar/Case Studies	Design Time Synchronization Mechanism in Distributed Gaming	
*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 Tolerant 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, Checkpointing, Message Logging, Recovery Oriented Computing.		
#Exemplar/Case Studies	Study of any Open Source Tool for Building Fault-Tolerant System such as Circuit Breaker/Nginx/HaProxy/Akka	
*Mapping of Course Outcomes for Unit VI	CO6	

Learning Resources

Text Books:

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

Reference Books:

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

e-Books :

- Martin Kleppmann, “Designing Data-Intensive Applications”, Oreilly

MOOC Courses links:

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

@TheCO-POMappingMatrix

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

Savitribai Phule Pune University		
Third Year of Computer Science (2019 Course)		
Elective I		
310245(D): Software Project Management		
Teaching Scheme: TH: 03 Hours/Week	Credit: 03	Examination Scheme: Mid-Semester (TH) : 30 Marks End-Sem (paper): 70 Marks
Prerequisites Courses: Software Engineering (210253)		
Companion Course: Laboratory Practice III (310548)		
Course Objectives: <ul style="list-style-type: none">To understand the fundamentals of Software Project ManagementTo investigate software project planning and management toolsTo learn software project scheduling and trackingTo discuss about the agile project managementTo know people management in software project		
Course Outcomes: On completion of the course, learners should be able to <ul style="list-style-type: none">CO1: Comprehend Project Management ConceptsCO2: Use various tools of Software Project ManagementCO3: Schedule various activities in software projectsCO4: Track a project and manage changesCO5: Apply Agile Project ManagementCO6: Analyse 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 Flow type work, Project Lifecycle, Processes and Knowledge Areas in Project Management (PM), Build or Buy decision, Work Breakdown Structure (WBS) and its types, Introduction to PMBOK, Program and Portfolio Management.		
#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	Analyse the same project using Agile. Create the three stages of the project.	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Staffing in Software Projects	07 Hours
Managing People, Organizational behaviour, Best methods of Staff Selection, Motivation, The Oldham, Hackman job characteristic Model, Stress, Health and Safety, Ethical and Professional concerns, Working in Teams, Decision Making, Organizational structures, Dispersed and Virtual Teams, Communications Genres, Communication Plans.		
#Exemplar/Case Studies	Analyse a case study for a distributed team and comment	
*Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		
Text Books:		
<div>1. Bob Hughes, Mike Cotterell and Rajib Mall, “Software Project Management”, Sixth Edition, Tata McGraw Hill, New Delhi, 2017.</div> <div>2. Robert K. Wysocki, “Effective Software Project Management”, Wiley Publication, 2011.</div>		
Reference Books :		
<div>1. Ken Schwaber, “Agile Project Management”, Microsoft Press, 2004</div> <div>2. Walker Royce, “Software Project Management”, Addison-Wesley, 1998.</div> <div>3. Jalote Pankaj, “Software Project Management in Practice”, Addison-Wesley Professional, 2002</div> <div>4. PMBOK Guide</div>		
e-Books :		
<div>https://www.kornev-online.net/ITIL/Mcgraw.Hill.Software_Project_Management_2nd_Edition.pdf</div> <div>http://library.lol/main/B96E3B122326F8D2C6FBD35A5E978422</div>		
MOOCs Courses Links:		
<div>https://onlinecourses.nptel.ac.in/noc19_cs70/preview</div> <div>Software Project Management By Prof. Rajib Mall & Prof. Durga Prasad Mohapatra IIT Kharagpur</div>		

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University		
Third Year of Computer Science (2019 Course)		
310246:Database Management Systems Laboratory		
Teaching Scheme Practical: 04 Hours/Week	Credit Scheme: 02	Examination Scheme and Marks Term work: 25 Marks Practical: 25 Marks
Companion Course: Database Management Systems (310241)		
Course Objectives:		
<ul style="list-style-type: none">To develop Database programming skillsTo develop basic Database administration skillsTo develop skills to handle NoSQL databaseTo learn, understand and execute process of software application development		
Course Outcomes:		
On completion of the course, learners will be able to		
CO1: Design E-R Model for given requirements and convert the same into database tables		
CO2: Design schema in appropriate normal form considering actual requirements		
CO3: Implement SQL queries for given requirements , using different SQL concepts		
CO4: Implement PL/SQL Code block for given requirements		
CO5: Implement NoSQL queries using MongoDB		
CO6: Design and develop application considering actual requirements and using database concepts		
Guidelines for Instructor's Manual		
The instructor’s manual is to be developed as a reference and hands-on resource. It should include prologue (about University/program/ institute/ department/foreword/ preface), curriculum of the course, conduction and Assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.		
Guidelines for Student's Laboratory Journal		
The laboratory assignments are to be submitted by student in the form of journal. Journal consists of Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software and Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments are to be submitted as softcopy. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal must be avoided. Use of DVD containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory.		
Guidelines for Laboratory /Term Work Assessment		
Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student. Each Laboratory assignment assessment will assign grade/marks based on parameters, such as timely completion, performance, innovation, efficient codes, and punctuality.		
Guidelines for Practical Examination		
Problem statements must be decided jointly by the internal examiner and external examiner. During practical assessment, maximum weightage should be given to satisfactory implementation of the problem statement. Relevant questions may be asked at the time of evaluation to test the student’s understanding of the fundamentals, effective and efficient implementation. This will encourage, transparent evaluation and fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.		

Guidelines for Laboratory Conduction

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

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

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

Virtual Laboratory:

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

Suggested List of Laboratory Experiments/Assignments

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

Sr. No.	Group A: SQL and PL/SQL
1.	<p>ER Modeling and Normalization:</p> <p>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.</p> <p>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.</p>
2.	<p>SQL Queries:</p> <p>a. Design and Develop SQL DDL statements which demonstrate the use of SQL objects such as Table, View, Index, Sequence, Synonym, different constraints etc.</p> <p>b. Write at least 10 SQL queries on the suitable database application using SQL DML statements.</p> <p>Note: Instructor will design the queries which demonstrate the use of concepts like Insert, Select, Update, Delete with operators, functions, and set operator etc.</p>
3.	<p>SQL Queries - all types of Join, Sub-Query and View:</p> <p>Write at least 10 SQL queries for suitable database application using SQL DML statements.</p> <p>Note: Instructor will design the queries which demonstrate the use of concepts like all types of Join, Sub-Query and View</p>

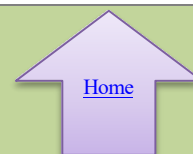
4.	<p>Unnamed PL/SQL code block: Use of Control structure and Exception handling is mandatory.</p> <p>Suggested Problem statement: Consider Tables:</p> <ol style="list-style-type: none"> 1. Borrower(Roll_no, Name, DateofIssue, NameofBook, Status) 2. Fine(Roll_no,Date,Amt) <ul style="list-style-type: none"> • Accept Roll_no and NameofBook 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. <p style="text-align: center;">OR</p> <p>Write a PL/SQL code block to calculate the area of a circle for a value of radius varying from 5 to 9. Store the radius and the corresponding values of calculated area in an empty table named areas, consisting of two columns, radius and area.</p> <p>Note: Instructor will frame the problem statement for writing PL/SQL block in line with above statement.</p>
5.	<p>Named PL/SQL Block: PL/SQL Stored Procedure and Stored Function.</p> <p>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 and 900 category is first class, if marks 899 and 825 category is Higher Second Class.</p> <p>Write a PL/SQL block to use procedure created with above requirement.</p> <p style="text-align: center;">Stud_Marks(name, total_marks) Result(Roll,Name, Class)</p> <p>Note: Instructor will frame the problem statement for writing stored procedure and Function in line with above statement.</p>
6.	<p>Cursors: (All types: Implicit, Explicit, Cursor FOR Loop, Parameterized Cursor)</p> <p>Write a PL/SQL block of code using parameterized Cursor that will merge the data available in the newly created table N_RollCall with the data available in the table O_RollCall. If the data in the first table already exist in the second table then that data should be skipped.</p> <p>Note: Instructor will frame the problem statement for writing PL/SQL block using all types of Cursors in line with above statement.</p>

7.	<p>Database Trigger (All Types: Row level and Statement level triggers, Before and After Triggers).</p> <p>Write a database trigger on Library table. The System should keep track of the records that are being updated or deleted. The old value of updated or deleted records should be added in Library_Audit table.</p> <p>Note: Instructor will Frame the problem statement for writing PL/SQL block for all types of Triggers in line with above statement.</p>
8.	<p>Database Connectivity:</p> <p>Write a program to implement MySQL/Oracle database connectivity with any front end language to implement Database navigation operations (add, delete, edit etc.)</p>
Group B: NoSQL Databases	
1.	<p>MongoDB Queries:</p> <p>Design and Develop MongoDB Queries using CRUD operations. (Use CRUD operations, SAVE method, logical operators etc.).</p>
2.	<p>MongoDB - Aggregation and Indexing:</p> <p>Design and Develop MongoDB Queries using aggregation and indexing with suitable example using MongoDB.</p>
3.	<p>MongoDB - Map reduces operations:</p> <p>Implement Map reduces operation with suitable example using MongoDB.</p>
4.	<p>Database Connectivity:</p> <p>Write a program to implement MongoDB database connectivity with any front end language to implement Database navigation operations (add, delete, edit etc.)</p>
Group C: Mini Project	
1.	<p>Using the database concepts covered in Group A and Group B, develop an application with following details:</p> <ol style="list-style-type: none"> Follow the same problem statement decided in Assignment -1 of Group A. Follow the Software Development Life cycle and other concepts learnt in Software Engineering Course throughout the implementation. Develop application considering: <ul style="list-style-type: none"> Front End : Java/Perl/PHP/Python/Ruby/.net/any other language Backend : MongoDB/MySQL/Oracle Test and validate application using Manual/Automation testing. Student should develop application in group of 2-3 students and submit the Project Report which will consist of documentation related to different phases of Software Development Life Cycle: <ul style="list-style-type: none"> 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. <p>Note:</p> <ul style="list-style-type: none"> 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	3	-	3	1	1	1	3	1	-	1
CO2	2	2	3	-	2	-	1	-	3	-	1	-
CO3	-	1	2	-	2	1	-	1	3	-	-	2
CO4	-	1	2	-	2	-	-	-	3	2	1	-
CO5	-	1	2	-	2	-	2	-	3	1	-	1
CO6	2	2	3	-	3	1	-	-	3	-	2	1

Savitribai Phule Pune University
Third Year of Computer Science (2019 Course)
310547:TCP/IP Networking Laboratory



Teaching Scheme
Practical: 02 Hours/Week

Credit Scheme: 01

Examination Scheme and Marks
Term work: 25 Marks
Oral: 25 Marks

Companion Course: TCP/IP Networking (310544)

Course Objectives:

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

Course Outcomes:

On completion of the course, learners will be able to

- CO1:** Implement web applications and services using application layer protocols
- CO2:** Develop Client-Server architectures and prototypes
- CO3:** Demonstrate the subnet formation with IP allocation mechanism and apply various routing algorithms
- CO4:** Demonstrate error control, flow control techniques and protocols and analyze them
- CO5:** Analyze the requirements of network types, topology and transmission media
- 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 implementations in term work. This will encourage, transparent evaluation and fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.

Guidelines for Laboratory Conduction

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

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

Programming tools recommended: - Open-Source /C/C++/JAVA

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

Virtual Laboratory:

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

Suggested List of Laboratory Experiments/Assignments

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

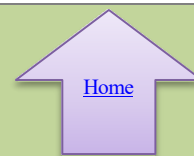
Sr. No.	Group A: Assignment Sr. No. 1 to 3 are Compulsory and attempt any three from Assignments Sr. No 4 to 10.
1	Write a program for DNS lookup. Given an IP address as input, it should return URL and vice versa.
2	Write a program using TCP socket for wired network for following a. Say Hello to Each other b. File transfer c. Calculator
3	Write a program using UDP Sockets to enable file transfer (Script, Text, Audio and Video one file each) between two machines.
4	Write a program to simulate Go back N and Selective Repeat Modes of Sliding Window Protocol in Peer-to-Peer mode.
5	Installing and configure DHCP server and write a program to install the software on remote machine.
6	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.
7	Study and Analyze the performance of HTTP, HTTPS and FTP protocol using Packet tracer tool.
8	To study the SSL protocol by capturing the packets using Wireshark tool while visiting any SSL secured website (banking, e-commerce etc.).
9	Illustrate the steps for implementation of S/MIME email security through Microsoft® Office Outlook.
10	To study the IPsec (ESP and AH) protocol by capturing the packets using Wireshark tool.
Group B: All assignments are compulsory	
11	Write a program to demonstrate Sub-netting and find subnet masks.
12	Write a program to implement link state /Distance vector routing protocol to find suitable path for transmission.
13	Use packet Tracer tool for configuration of 3 router network using one of the following protocol RIP/OSPF/BGP.
14	Write a program for error detection and correction for 7/8 bits ASCII codes using Hamming Codes or CRC.

Group C: Attempt any two from Assignments Sr. No 15 to 17.	
15	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.
16	Demonstrate the different types of topologies and types of transmission media by using a packet tracer tool.
17	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).

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Science (2019 Course)
310548: Laboratory Practice III



Teaching Scheme
Practical: 04 Hours/Week

Credit Scheme: 02

Examination Scheme and Marks
Term work: 25 Marks
Oral: 25 Marks

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

Course Objectives:

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

Course Outcomes:

On completion of the course, learners will be able to

• **Systems Programming and Operating System**

CO1: Implement language translators

CO2: Use tools like LEX and YACC

CO3: Implement internals and functionalities of Operating System

• **Internet of Things and Embedded Systems**

CO4: Design IoT and Embedded Systems based application

CO5: Develop smart applications using IoT

CO6: Develop IoT applications based on cloud environment

OR

• **Human Computer Interface**

CO4: Implement the interactive designs for feasible data search and retrieval

CO5: Analyze the scope of HCI in various paradigms like ubiquitous computing, virtual reality, multi-media, World wide web related environments

CO6: Analyze and identify user models, user support, socio-organizational issues, and stakeholder requirements of HCI systems

OR

• **Distributed Systems**

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

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

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

OR

• **Software Project Management**

CO4: Apply Software Project Management tools

CO5: Implement software project planning and scheduling

CO6: 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, concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Laboratory Journal

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

Guidelines for Laboratory /Term Work Assessment

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

Guidelines for Practical Examination

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

Guidelines for Laboratory Conduction

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

Programming tools recommended: -

Human computer Interface-GUI in python

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

Software project management-MS project/Gantt Project/Primavera

Virtual Laboratory:

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

Suggested List of Laboratory Experiments/Assignments

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

Part I: Systems Programming and Operating System

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

2.	Design suitable data structures and implement Pass-I and Pass-II of a two-pass macro-processor. The output of Pass-I (MNT, MDT and intermediate code file without any macro definitions) should be input for Pass-II.
3.	Write a program to recognize infix expression using LEX and YACC.
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.	<u>Write a program to simulate</u> CPU Scheduling Algorithms: FCFS, SJF (Preemptive), Priority (Non-Preemptive) and Round Robin (Preemptive).
6.	<u>Write a program to simulate</u> Memory placement strategies – best fit, first fit, next fit and worst fit.
7.	<u>Write a program to simulate</u> Page replacement algorithm.
Part II : Elective I	
Suggested List of Laboratory Experiments/Assignments (Any Two assignments from each elective subject are compulsory and Instructor will take care that all the assignments should be covered among different batch students)	
Internet of Things and Embedded Systems	
1.	Understanding the connectivity of Raspberry-Pi / Arduino with IR sensor. Write an application to detect obstacle and notify user using LEDs.
2.	Understanding the connectivity of Raspberry-Pi / Beagle board circuit with temperature sensor. Write an application to read the environment temperature. If temperature crosses a threshold value, generate alerts using LEDs.
3.	Understanding and connectivity of Raspberry-Pi / Beagle board with camera. Write an application to capture and store the image.
4.	Create a small dashboard application to be deployed on cloud. Different publisher devices can publish their information and interested application can subscribe.
Human Computer Interface	
1.	Design a paper prototype for selected Graphical User Interface.
2.	Implement GOMS (Goals, Operators, Methods and Selection rules) modeling technique to model user's behavior in given scenario.
3.	Design a User Interface in Python.
4.	To redesign existing Graphical User Interface with screen complexity.
Distributed System	
1.	Implementation of Inter-process communication using socket programming: implementing multithreaded echo server.
2.	Implementation of RPC Mechanism.
3.	Simulation of election algorithms (Ring and Bully).
4.	Implementation of Clock Synchronization: a) NTP b) Lamports clock.
Software Project Management	
1.	Create Project Plan <ul style="list-style-type: none"> ▪ Specify project name and start (or finish) date. ▪ Identify and define project tasks. ▪ Define duration for each project task. ▪ Define milestones in the plan ▪ Define dependency between tasks ▪ Define project calendar. ▪ Define project resources and specify resource type ▪ Assign resources against each task and baseline the project plan

2.	Execute and Monitor Project Plan <ul style="list-style-type: none"> ▪ 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 assignation status
3.	Generate Dashboard and Reports <ul style="list-style-type: none"> ▪ Dashboard <ul style="list-style-type: none"> o Project Overview o Cost Overview o Upcoming Tasks • Resource Reports <ul style="list-style-type: none"> o Over-allocated Resources o Resource Overview ▪ Cost Reports <ul style="list-style-type: none"> o Earned Value Report o Resource Cost Overview o Task Cost Overview ▪ Progress Reports <ul style="list-style-type: none"> o Critical Tasks o Milestone Report o Slipping Tasks

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

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

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

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

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

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

CO5	2	2	2	1	2	-	-	-	-	-	-	-
CO6	2	3	3	2	2	-	-	-	-	-	-	-
<u>@The CO-PO Mapping Matrix (SPOS and SPM)</u>												
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	-	-	-	-	-	1	-	3	-
CO5	-	-	-	-	2	-	-	-	1	-	3	-
CO6	-	-	-	-	-	-	-	-	2	-	3	-

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


[Home](#)
Teaching Scheme**Practical: 01 Hours/Week****Credit Scheme****01****Examination Scheme and Marks****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 Science and Technology preferably keeping track with recent technological trends and development beyond scope of syllabus avoiding repetition in consecutive years.
- The topic must be selected in consultation with the Institute guide.
- Each student will make a seminar presentation using audio/visual aids for a duration of 20-25 minutes and submit the seminar report prepared in Latex only.
- Active participation at classmate seminars is essential.
- BoS has circulated the Seminar Log book and it is recommended to use it.

Guidelines for Assessment

Panel of staff members along with a guide would be assessing the seminar work based on these parameters-Topic, Contents and Presentation, regularity, Punctuality and Timely Completion, Question and Answers, Report, Paper presentation/Publication, Attendance and Active Participation.

Recommended Format of the Seminar Report

- Title Page with Title of the topic, Name of the candidate with Exam Seat Number / Roll Number, Name of the Guide, Name of the Department, Institution and Year and University
- Seminar Approval Sheet/Certificate
- Abstract and Keywords
- Acknowledgements
- Table of Contents, List of Figures, List of Tables and Nomenclature
- Chapters Covering topic of discussion- Introduction with section including organization of the report, Literature Survey/Details of design/technology/Analytical and/or experimental work, if any/,Discussions and Conclusions ,Bibliography/References
- Plagiarism Check report
- Report Documentation page

Reference Books :

1. Rebecca Stott, Cordelia Bryan, Tory Young, "Speaking Your Mind: Oral Presentation and Seminar Skills (Speak-Write Series)", Longman, ISBN-13: 978-0582382435

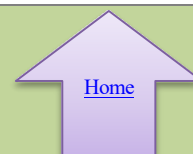
2. Johnson-Sheehan, Richard, “Technical Communication”, Longman. ISBN 0-321-11764-6

3. Vikas Shirodka, “Fundamental skills for building Professionals”, SPD, ISBN 978-93-5213- 146-5

@The CO-PO Mapping Matrix

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 5



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

Criteria

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

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

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

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

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

Audit Course 5 Options

Audit Course Code	Audit Course Title
AC5-I	Cyber Security
AC5-II	Professional Ethics and Etiquette
AC5-III	MOOC- Learn New Skills
AC5- IV	Engineering Economics
AC5-V	Foreign Language (one of Japanese/ Spanish/ French/ German). Course contents for Japanese (Module 3) are provided. For other languages institute may design suitably.

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

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

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

AC5-I: Cyber Security**Prerequisites:** TCP/IP Networking (310544)**Course Objectives:**

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

Course Outcomes : On completion of the course, learners will be able to**CO 1:** Understand and classify various cybercrimes**CO 2:** Understand how criminals plan for the cybercrimes**CO 3:** Apply tools and methods used in cybercrime**CO 4:** Analyze the examples of few case studies of cybercrimes**Course Contents**

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

Text Books :

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

Reference Books :

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

@The CO-PO Mapping Matrix

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

AC5-II: Professional Ethics and Etiquettes**Prerequisites:** Business Communication Skill**Course Objectives:**

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

Course Outcomes:

On completion of the course, learners will be able to

CO1: Summarize the principles of proper courtesy as they are practiced in the workplace**CO2:** Apply proper courtesy in different professional situations**CO3:** Practice and apply appropriate etiquettes in the working environment and day to day life**CO4:** Build proper practices personal and business communications of Ethics and Etiquettes**Course Contents**

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

References Books:

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

@The CO-PO Mapping Matrix

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

AC5-III: MOOC- Learn New Skills (Full stack Developer)**Prerequisites:** Programming Skills**Course Objectives:**

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

Course Outcomes:

On completion of the course, learners will be able to

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

CO2: Design and develop dynamic and scalable web applications

CO3: Develop server side scripts

CO4: Design and develop projects applying various database techniques

Course Contents

Full stack Developer

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

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

Reference Books:

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

@The CO-PO Mapping Matrix

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

AC5-IV: Engineering Economics

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

Course Objectives:

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

Course Outcomes:

On completion of the course, learners will be able to

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

CO2: Analyze business economics and engineering assets evaluation

CO3: Evaluate project cost and its elements for business

CO4: Develop financial statements and make business decisions

Course Contents

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

Reference Books :

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

@The CO-PO Mapping Matrix

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

AC5-V: Foreign Language (Japanese) Module 3

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

Course Objectives:

- To open up more doors and job opportunities
- To introduce to Japanese society, culture and entertainment

Course Outcomes:

On completion of the course, learners will be able to

CO1: Apply language to communicate confidently and clearly in the Japanese language

CO2: Understand and use Japanese script to read and write

C03: Apply knowledge for next advance level reading, writing and listening skills

C04: Develop interest to pursue further study, work and leisure

Course Contents

1. The Kanji: Brief Historical Outline, Introduction to Kanji, From Pictures to characters
2. Read and Write 58 Kanji Characters, talk about yourself/family/others, things, time, events, and activities-in the present, future, and past tense; shop at stores and order food at restaurants;
3. Lessons: Karate, Park(Playground), The Grandpa's Inaka, The Sun and the Moon, My little sister, Rice Fields, My Teacher, People who Exit and People who Enter.

Reference Books :

1. Japanese Kanji and Kana, “A complete guide to the Japanese writing system”, Wolfgang Hadamitzky & Mark Spahn, Tuttle Publishing, Third edition ISBN: 978-1-4629-1018-2 (eBook)
2. Banno, Eri, Yoko Ikeda, et al. Genki I, “An Integrated Course in Elementary Japanese”, 2nd ed. Japan Times/Tsai Fong Books, 2011. ISBN: 9784789014403.
3. Anna Sato and Eriko Sato, “My First Japanese Kanji Book, Learning kanji the fun and easy way”, TUTTLE PUBLISHING, First Edition ISBN: 978-1-4629-1369-5 (eBook)

@The CO-PO Mapping Matrix

[illegible]

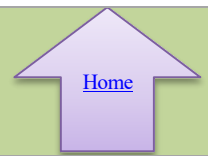
Curriculum for Third Year of Computer Science (2019 Course)



Semester VI

(With effect from 2025-26)

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



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

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

Course Objectives:

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

Course Outcomes:

After completion of the course, learners should be able to

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

CO2: Apply statistics for Big Data Analytics

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

CO4: Implement Big Data Analytics using Python programming

CO5: Implement data visualization using visualization tools in Python programming

CO6: Design and implement Big Databases using the Hadoop ecosystem

Course Contents

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, matplotlib, filling missing values, Regression and Classification using Scikit-learn.		
#Exemplar/Case Studies	Use IRIS dataset from Scikit and apply data preprocessing methods	
*Mapping of Course Outcomes for Unit IV	CO4,CO2	
Unit V	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 Subsampling, Parameter Tuning and Optimization, Result Interpretation, Clustering and Time-series analysis using Scikit-learn, sklearn.metrics, Confusion matrix, AUC-ROC Curves, Elbow plot.		
#Exemplar/Case Studies	Use IRIS dataset from Scikit and apply K-means clustering methods	
*Mapping of Course Outcomes for Unit V	CO4, CO2	
Unit VI	Data Visualization and Hadoop	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:		
<div>1. David Dietrich, Barry Hiller, “Data Science and Big Data Analytics”, EMC education services, Wiley publication, 2012, ISBN0-07-120413-X.</div> <div>2. Jiawei Han, Micheline Kamber, and Jian Pie, “Data Mining: Concepts and Techniques” Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807</div>		
Reference Books :		
<div>1. EMC Education Services, “Data Science and Big Data Analytics- Discovering, analyzing Visualizing and Presenting Data”</div> <div>2. DT Editorial Services, “Big Data, Black Book”, DT Editorial Services, ISBN: 9789351197577, 2016 Edition.</div> <div>3. Chirag Shah, “A Hands-On Introduction To Data Science”, Cambridge University Press, (2020), ISBN : ISBN 978-1-108-47244-9.</div> <div>4. Wes McKinney, “Python for Data Analysis” O' Reilly media, ISBN: 978-1-449-31979-3.</div> <div>5. “Scikit-learn Cookbook”, Trent hauk, Packt Publishing, ISBN: 9781787286382</div>		

6. Jenny Kim, Benjamin Bengfort, “Data Analytics with Hadoop”, OReilly Media, Inc., ISBN: 9781491913703.
7. Venkat Ankam, “Big Data Analytics”, Packt Publishing, ISBN: 9781785884696

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://tanthamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf>
- Introducing Data Science by Davy Ciele, Manning Publications
- Introducing Data Science [PDF]
- Handbook for visualizing : a handbook for data driven design by Andy krik
- A Handbook for Data Driven Design
- An introduction to data Science :
<https://docs.google.com/file/d/0B6iefdnF22XQeVZDSkxjZ0Z5VUE/edit?pli=1>
- Hadoop Tutorial :
https://www.tutorialspoint.com/hadoop/hadoop_tutorial.pdf?utm_source=7_&utm_medium=affiliate&utm_content=5f34cd37cdf1050001b09537&utm_campaign=Admitad&utm_term=761c575424fc4a6b48d02f72157eb578
- Learning with Python; How to think like a computer scientist:
<http://openbookproject.net/thinkcs/python/english3e/>
- Python for everybody:
http://do1.dr-chuck.com/pythonlearn/EN_us/pythonlearn.pdf
- Scikit Learn Tutorial
- <https://scikit-learn.org/stable/>

MOOCs Courses links:

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University		
Third Year of Computer Science (2019 Course)		
310252: Web Technology		
Teaching Scheme: TH: 03 Hours/Week	Credit: 03	Examination Scheme: Mid-Sem (TH) : 30 Marks End-Sem (TH): 70 Marks
Prerequisites Courses: Database Management Systems (310341), TCP/IP Networking (310544)		
Companion Course: Web Technology Laboratory (310257)		
Course Objectives: <ul style="list-style-type: none">To learn the fundamentals of web essentials and markup languagesTo use the Client side technologies in web developmentTo use the Server side technologies in web developmentTo understand the web services and frameworks		
Course Outcomes: <p>On completion of the course, learners should be able to</p> <p>CO1: Implement and analyze behavior of web pages using HTML and CSS</p> <p>CO2: Apply the client side technologies for web development</p> <p>CO3: Analyze the concepts of Servlet and JSP</p> <p>CO4: Analyze the Web services and frameworks</p> <p>CO5: Apply the server side technologies for web development</p> <p>CO6: Create the effective web applications for business functionalities using latest web development platforms</p>		
Course Contents		
Unit I	Web Essentials and Mark-up language-HTML	07 Hours
The Internet, basic internet protocols, the world wide web, HTTP Request message, HTTP response message, web clients, web servers. HTML: Introduction, history and versions. HTML elements: headings, paragraphs, line break, colors and fonts, links, frames, lists, tables, images and forms, Difference between HTML and HTML5. CSS: Introduction to Style Sheet, CSS features, CSS core syntax, Style sheets and HTML, Style rule cascading and inheritance, text properties. Bootstrap.		
#Exemplar/Case Studies	Create a style sheet suitable for blogging application using HTML and using style sheet	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	Client Side Technologies: JavaScript and DOM	07 Hours
JavaScript: Introduction to JavaScript, JavaScript in perspective, basic syntax, variables and data types, statements, operators, literals, functions, objects, arrays, built in objects, JavaScript debuggers. DOM: Introduction to Document Object Model, DOM history and levels, intrinsic event handling, modifying element style, the document tree, DOM event handling, jQuery, Overview of Angular JS.		
#Exemplar/Case Studies	Enhancement in created blogging application using JavaScript (Add Entry feature)	
*Mapping of Course Outcomes for Unit II	CO2	

Unit III	Java Servlets and XML	07 Hours
Servlet: Servlet architecture overview, A “Hello World” servlet, Servlets generating dynamic content, Servlet life cycle, parameter data, sessions, cookies, URL rewriting, other Servlet capabilities, data storage, Servlets concurrency, databases (MySQL) and Java Servlets. XML: XML documents and vocabularies, XML declaration, XML Namespaces, DOM based XML processing, transforming XML documents, DTD: Schema, elements, attributes. AJAX: Introduction, Working of AJAX.		
#Exemplar/Case Studies	Develop server-side code for blogging application	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	JSP and Web Services	07 Hours
JSP: Introduction to Java Server Pages, JSP and Servlets, running JSP applications, Basic JSP, JavaBeans classes and JSP, Support for the Model-view-controller paradigm, JSP related technologies. Web Services: Web Service concepts, Writing a Java Web Service, Writing a Java web service client, Describing Web Services: WSDL, Communicating Object data: SOAP. Struts: Overview, architecture, configuration, actions, interceptors, result types, validations, localization, exception handling, annotations.		
#Exemplar/Case Studies	Transform the blogging application from a loose collection of various resources (servlets, HTML documents, etc.) to an integrated web application that follows the MVC paradigm	
*Mapping of Course Outcomes for Unit IV	CO3, CO4	
Unit V	Server Side Scripting Languages	07 Hours
PHP: Introduction to PHP, uses of PHP, general syntactic characteristics, Primitives, operations and expressions, output, control statements, arrays, functions, pattern matching, form handling, files, cookies, session tracking, using MySQL with PHP, WAP and WML. Introduction to ASP.NET: Overview of the .NET Framework, Overview of C#, Introduction to ASP.NET, ASP.NET Controls, Web Services. Overview of Node JS.		
#Exemplar/Case Studies	Use of PHP in developing blogging application.	
*Mapping of Course Outcomes for Unit V	CO5, CO6	
Unit VI	Ruby and Rails	07 Hours
Introduction to Ruby: Origins & uses of Ruby, scalar types and their operations, simple input and output, control statements, fundamentals of arrays, hashes, methods, classes, code blocks and iterators, pattern matching. Introduction to Rails: Overview of Rails, Document Requests, Processing Forms, Rails Applications and Databases, Layouts, Rails with Ajax. Introduction to EJB.		
#Exemplar/Case Studies	Study of dynamic web product development using ruby and rails	
*Mapping of Course Outcomes for Unit VI	CO6	
Learning Resources		
Text Books: 1. Jeffrey C.Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035.		

- Robert W. Sebesta, "Programming the World Wide Web", 4th Edition, Pearson education, 2008.

Reference Books :

- Marty Hall, Larry Brown, "Core Web Programming", Second Edition, Pearson Education, 2001, ISBN 978-0130897930.
- 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.
- Chris Bates, "Web Programming Building Internet Applications", 3rd Edition, Wiley India, 2006.
- Xue Bai et al, "The web Warrior Guide to Web Programming", Thomson, 2003.

e-Books :

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

MOOCs Courses link

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University Third Year of Computer Science (2019 Course) 310253: Artificial Intelligence		
Teaching Scheme: TH: 03 Hours/Week	Credit: 03	Examination Scheme: Mid-Sem (TH) : 30 Marks End-Sem (TH): 70 Marks
Prerequisites Courses: Programming and Problem solving (110005), Data Structures and Algorithms (210252)		
Companion Course: Laboratory Practice IV (310558)		
Course Objectives: <ul style="list-style-type: none"> To understand the concept of Artificial Intelligence (AI) in the form of various Intellectual tasks To understand Problem Solving using various peculiar search strategies for AI To understand multi-agent environment in competitive environment To acquaint with the fundamentals of knowledge and reasoning To devise plan of action to achieve goals as a critical part of AI To develop a mind to solve real world problems unconventionally with optimality 		
Course Outcomes: After completion of the course, students should be able to CO1: Identify and apply suitable Intelligent agents for various AI applications CO2: Build smart system using different informed search / uninformed search or heuristic approaches CO3: Identify knowledge associated and represent it by ontological engineering to plan a strategy to solve given problem CO4: Apply the suitable algorithms to solve AI problems CO5: Implement ideas underlying modern logical inference systems CO6: Represent complex problems with expressive yet carefully constrained language of representation		
Course Contents		
Unit I	Introduction	07 Hours
Introduction to Artificial Intelligence, Foundations of Artificial Intelligence, History of Artificial Intelligence, State of the Art, Risks and Benefits of AI, Intelligent Agents, Agents and Environments, Good Behavior: Concept of Rationality, Nature of Environments, Structure of Agents.		
#Exemplar/Case Studies	Kroger: How This U.S. Retail Giant Is Using AI And Robots To Prepare For The 4th Industrial Revolution	
*Mapping of Course Outcomes for Unit I	CO1, CO4	
Unit II	Problem-solving	07 Hours
Solving Problems by Searching, Problem-Solving Agents, Example Problems, Search Algorithms, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions, Search in Complex Environments, Local Search and Optimization Problems.		
#Exemplar/Case Studies	4th Industrial Revolution Using AI, Big Data And Robotics	
*Mapping of Course Outcomes for Unit II	CO2, CO4	

Unit III	Adversarial Search and Games	07 Hours
Game Theory, Optimal Decisions in Games, Heuristic Alpha–Beta Tree Search, Monte Carlo Tree Search, Stochastic Games, Partially Observable Games, Limitations of Game Search Algorithms, Constraint Satisfaction Problems (CSP), Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs.		
#Exemplar/Case Studies	Machine Learning At Google: The Amazing Use Case Of Becoming A Fully Sustainable Business	
*Mapping of Course Outcomes for Unit III	CO3, CO4	
Unit IV	Knowledge	07 Hours
Logical Agents, Knowledge-Based Agents, The Wumpus World, Logic, Propositional Logic: A Very Simple Logic, Propositional Theorem Proving, Effective Propositional Model Checking, Agents Based on Propositional Logic, First-Order Logic, Representation Revisited, Syntax and Semantics of First-Order Logic, Using First-Order Logic, Knowledge Engineering in First-Order Logic.		
#Exemplar/Case Studies	BBC To Launch AI - Enabled Interactive Radio Show For Amazon Echo And Google Home Chatbots	
*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

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/>

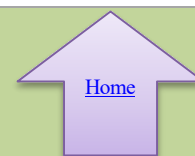
NPTEL video lecture link

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

@The CO-PO Mapping Matrix

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

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



Teaching Scheme: TH: 03 Hours/Week	Credit: 03	Examination Scheme: Mid-Sem (TH) : 30 Marks End-Sem (TH): 70 Marks
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Prerequisites Courses: -- TCP/IP Networking (310544)

Companion Course: -- Laboratory Practice IV (310558)

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	05 Hours
Foundations of Security, Computer Security Concepts, The OSI Security Architecture, Security attacks, Security services, Security mechanism, A Model for Network Security.		
#Exemplar/Case Studies	Open Source/ Free/ Trial Tools: ClamAV 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, Monoalphabetic Ciphers, Playfair Cipher, Hill Cipher, Polyalphabetic Ciphers, Transposition Techniques, Block Ciphers 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 number, Fermat and Euler theorems , Testing for primality, Chinese reminder theorem, discrete logarithm, Public Key Cryptography and RSA, Diffie-Hellman key exchange, ElGamal algorithm, Elliptic Curve Cryptography		
#Exemplar/Case Studies	Open Source/ Free/ Trial Tools: crypt tool	
*Mapping of Course Outcomes for Unit III	CO2	
Unit IV	Data Integrity Algorithms And Web Security	09 Hours
Cryptographic Hash Functions: 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, X.509 Certificate. Web Security issues, HTTPS, SSH, Email security: PGP, S/MIME, IP Security : IPSec		
#Exemplar/Case Studies	Open Source/ Free/ Trial Tools: OpenSSL, 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, Classification of Cybercrimes, The legal perspectives-Indian perspective, Global perspective, Categories of Cybercrime, Social Engineering, Cyber stalking, Proxy servers and Anonymizers, Phishing, Password Cracking, Key-loggers and Spywares, The Indian IT Act-Challenges, Amendments, Challenges to Indian Law and Cybercrime Scenario in India, Indian IT Act.		
#Exemplar/Case Studies	Study of any two network security scanners: Nmap, Metasploit, OpenVAS, Aircrack, Nikito, Samurai, Safe 3 etc.	
*Mapping of Course Outcomes for Unit VI	CO5	
Learning Resources		
Text Books :		
1. William Stallings, Lawrie Brown, “Computer Security Principles and Practice”, 3rd_Edition, Pearson , ISBN : 978-0-13-3777392-7		
2. William Stallings, “Cryptography and Network Security Principals and Practice”, Seventh edition, Pearson , ISBN : 978-1-292-15858		

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

Reference Books :

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

e-Books :

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

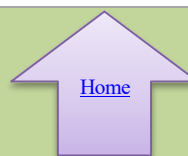
MOOCs Courses link

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Science (2019 Course)
Elective II
310554B: ADVANCED TCP/IP



Teaching Scheme:
TH: 03 Hours/Week

Credit: 03

Examination Scheme:
Mid-Semester (TH) : 30 Marks
End-Sem (TH): 70 Marks

Prerequisites Courses:

Companion Course: Laboratory Practice IV (310558)

Course Objectives:

- To understand the Client-Server model, server complexities, and network communication protocols.
- To understand the hierarchical structure of DNS, explore the domain name resolution process, and analyze the impact of DNS caching on performance.
- To understand various application layer protocols, including File Transfer Protocol (FTP), Simple Mail Transfer Protocol (SMTP), and Hypertext Transfer Protocol (HTTP)

Course Outcomes:

On completion of the course, learners should be able to

- CO1:** Students will be able to understand and implement Client-Server models, perform socket programming for data communication, and apply network protocols and services for efficient data exchange.
- CO2:** Students will be able to understand and implement BOOTP and DHCP protocols, including their operations, message formats, and role in IP address allocation.
- CO3:** Students will be able to understand the hierarchical structure of DNS, perform domain name resolution, and analyze the impact of DNS caching on network performance.
- CO4:** Students will be able to demonstrate proficiency in application layer protocols by effectively configuring and managing FTP, SMTP, and HTTP
- CO5:** Students will be able to understand and apply TELNET and Rlogin protocols, including their concepts, operations, timesharing environments, and Network Virtual Terminals (NVT) for remote system access.
- CO6:** Students will be able to understand and apply Voice over IP (VoIP) concepts, including RTP, RSVP operations for efficient real-time communication.

Course Contents

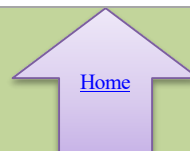
Unit I	Introduction to Client-Server environment	07 Hours
Introduction Client-Server model, complexity of servers, RARP servers, UNIX IO paradigm and Network IO, Sending and Receiving data through a Socket, IP address manipulation routines, Obtaining Information about Host, Networks Protocols and Network services.		
#Exemplar/Case Studies	Client-Server Model and Network Communication Using Sockets	
*Mapping of Course Outcomes for Unit I	CO1	
Unit II	BOOTP and DHCP	07 Hours
BOOTP Operations, BOOTP Message format, DHCP Operations, DHCP Message format.		
#Exemplar/Case Studies	A Comparative Study of BOOTP and DHCP Operations and Message Formats"	

*Mapping of Course Outcomes for Unit II		CO2
Unit III	Domain Name System	08 Hours
Hierarchical Name space, Domain Name Space: Label. Domain name, FQDN, Distribution of Name space: Hierarchy of Name space, Zone, Root servers, DNS in the Internet, Resolution: Mapping Names to Address, Mapping Address to Names, Recursive resolution, Iterative resolution, caching, Types of Record: Resource record, Zone Delegation, Zone Transfer, DDNS		
#Exemplar/Case Studies	Efficient Domain Name Resolution and Zone Management in the Internet Using DNS	
*Mapping of Course Outcomes for Unit III		CO3
Unit IV	Internet Communication Protocols	07 Hours
File Transfer Protocol- FTP, FTP features, process model, TFTP, NFS implementation, RPC. Simple Mail Transfer Protocol- SMTP, User Agent, Addresses, Mail Transfer Agent, Mail transfer phases, MIME, Multi part messages, POP. Hyper Text transfer Protocols- Architectural components, URL, HTTP transactions, Response Message, Header, WWW.		
#Exemplar/Case Studies	Comprehensive Study and Implementation of FTP, SMTP, and HTTP Protocols	
*Mapping of Course Outcomes for Unit IV		CO4
Unit V	Remote Access Protocols	06 Hours
TELNET and Rlogin- Concept of Telnet, Telnet Protocol and options, Timesharing Environments, Network Virtual Terminals (NVT), Mode of operations, Rlogin.		
#Exemplar/Case Studies	Exploring Remote System Access through TELNET and Rlogin Protocols	
*Mapping of Course Outcomes for Unit V		CO5
Unit VI	Real Time Transfer Protocol	06 Hours
Voice Over IP (RTP)- Real Time Transfer Protocol, RTP encapsulation, RTP Control protocol, operation, QoS, RSVP.		
#Exemplar/Case Studies	Explore the functionality of RTP in VoIP communication.	
*Mapping of Course Outcomes for Unit VI		CO6
Learning Resources		
Text Books : <ul style="list-style-type: none">Douglas Comer, Internetworking with TCP/IP, Principles, Protocols and Architecture, Volume 1, Pearson Education Asia		
Reference Books : <ul style="list-style-type: none">Behrouz Forouzan, TCP/IP Protocol suite, Tata McGraw-Hill EditionKarnjit S. Siyan, Inside TCP/IP TechmediaPete Loshin, TCP/IP Clearly Explained, Morgan Kaufmann Publications		

@The CO-PO Mapping Matrix

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

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



Teaching Scheme:
TH: 03 Hours/Week

Credit: 03

Examination Scheme:
Mid-Semester (TH) : 30 Marks
End-Sem (TH): 70 Marks

Prerequisites Courses: TCP/IP Networking (310544),
Distributed System (310245C)

Companion Course: Laboratory Practice IV (310558)

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

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

#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: Paravirtualization, VMware: Full Virtualization, Microsoft Hyper-V	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	Cloud Platforms and Cloud Applications	07 Hours
Amazon Web Services (AWS): Amazon Web Services and Components, Amazon Simple DB, Elastic Cloud Computing (EC2), Amazon Storage System, Amazon Database services (Dynamo DB). Microsoft Cloud Services: Azure core concepts, SQL Azure, Windows Azure Platform Appliance. Cloud Computing Applications: Healthcare: ECG Analysis in the Cloud, Biology: Protein Structure Prediction, Geosciences: Satellite Image Processing, Business and Consumer Applications: CRM and ERP, Social Networking, Google Cloud Application: Google App Engine. Overview of OpenStack architecture.		
#Exemplar/Case Studies	Multiplayer Online Gaming	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	Security in Cloud Computing	07 Hours
Risks in Cloud Computing: Risk Management, Enterprise-Wide Risk Management, Types of Risks in Cloud Computing. Data Security in Cloud: Security Issues, Challenges, advantages, Disadvantages, Cloud Digital persona and Data security, Content Level Security. Cloud Security Services: Confidentiality, Integrity and Availability, Security Authorization Challenges in the Cloud, Secure Cloud Software Requirements, Secure Cloud Software Testing.		
#Exemplar/Case Studies	Cloud Security Tool: Acunetix.	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	Advanced Techniques in Cloud Computing	07 Hours
Future Trends in cloud Computing, Mobile Cloud, Automatic Cloud Computing: Comet Cloud. Multimedia Cloud: IPTV, Energy Aware Cloud Computing, Jungle Computing, Distributed Cloud Computing Vs Edge Computing, Containers, Docker, and Kubernetes, Introduction to DevOps. IOT and Cloud Convergence: The Cloud and IoT in your Home, The IOT and cloud in your Automobile, PERSONAL: IoT in Healthcare.		
#Exemplar/Case Studies	Case studies on DevOps: DocuSign, Forter, Gengo.	
*Mapping of Course Outcomes for Unit VI	CO6	

Learning Resources

Text Books :

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

Reference Books :

1. James Bond, "The Enterprise Cloud", O'Reilly Media, Inc. ISBN: 9781491907627
2. Dr. Kris Jamsa, "Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more", Wiley Publications, ISBN: 978-0-470-97389-9
3. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach", 2010, The McGraw-Hill.
4. Gautam Shrof, "ENTERPRISE CLOUD COMPUTING Technology Architecture, Applications", Cambridge University Press, ISBN: 9780511778476
5. Tim Mather, Subra K, Shahid L., "Cloud Security and Privacy", Oreilly, ISBN-13 978-81-8404-815-5

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>

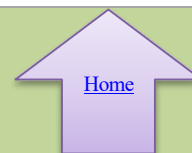
MOOCs Courses link:

- Cloud Computing https://onlinecourses.nptel.ac.in/noc21_cs14/preview?
- Cloud Computing and Distributed System: https://onlinecourses.nptel.ac.in/noc21_cs15/preview?
- <https://www.digimat.in/nptel/courses/video/106105167/L01.html>
- <https://www.digimat.in/nptel/courses/video/106105167/L03.html>
- <https://www.digimat.in/nptel/courses/video/106105167/L20.html>

@The CO-PO Mapping Matrix

CO/ PO	PO 1	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 Science (2019 Course)



Elective II
310254(D): Software Modelling and Architecture

Teaching Scheme: TH: 03 Hours/Week	Credit: 03	Examination Scheme: Mid-Semester (TH) : 30 Marks End-Sem (TH): 70 Marks
Prerequisites Courses: Object Oriented Programming (210243), Software Engineering (210253)		
Companion Course: Laboratory Practice IV (310558)		
Course Objectives: <ul style="list-style-type: none"> ● To understand and apply Object Oriented concept for designing Object Oriented based model or application ● To transform Requirement document to appropriate design ● To acquaint with the interaction between quality attributes and software architecture ● To understand different architectural designs, transform them into proper model and document them ● To understand software architecture with case studies and explore with examples, use of design pattern application 		
Course Outcomes: On completion of the course, learners should be able to CO1: Analyze the problem statement (SRS) and choose proper design technique for designing web-based/ desktop application CO2: Design and analyze an application using UML modeling as fundamental tool CO3: Evaluate software architectures CO4: Use appropriate architectural styles and software design patterns CO5: Apply appropriate modern tool for designing and modeling		
Course Contents		
Unit I	Concepts of Software Modelling	07 Hours
Software Modelling: Introduction to Software Modelling, Advantages of modelling, Principles of modelling. Evolution of Software Modeling and Design Methods: Object oriented analysis and design methods, Concurrent, Distributed Design Methods and Real-Time Design Methods, Model Driven Architecture (MDA), 4+1 Architecture, Introduction to UML, UML building Blocks, COMET Use Case–Based Software Life Cycle. Requirement Study: Requirement Analysis, SRS design, Requirements Modeling. Use Case: Actor and Use case identification, Use case relationship (Include, Extend, Use case Generalization, Actor Generalization), Use case template.		
#Exemplar/Case Studies	Requirement modelling and use case modelling for Real life applications (e.g., Online shopping system)	
*Mapping of Course Outcomes for Unit I	CO1, CO2	
Unit II	Static Modelling	07 Hours
Study of classes (analysis level and design level classes). Methods for identification of classes: RUP (Rational Unified Process), CRC (Class, Responsibilities and Collaboration), Use of Noun Verb analysis (for identifying entity classes, controller classes and boundary classes). Class Diagram: Relationship between classes, Generalization/Specialization Hierarchy, Composition and Aggregation Hierarchies, Associations Classes, Constraints.		

Object diagram, Package diagram, Component diagram, Composite Structure diagram, Deployment Diagram.		
#Exemplar/Case Studies		UML Static Diagrams for Real life applications (e.g., Online shopping system).
*Mapping of Course Outcomes for Unit II		CO1 ,CO2
Unit III	Dynamic Modelling	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 for 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 Structure 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		CO4, 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. Gardy Booch, James Rumbaugh, Ivar Jacobson, “The unified modeling language user guide”, Pearson Education, Second edition, 2008, ISBN 0-321-24562
3. Ian Sommerville, “Software Engineering”, Addison and Wesley, ISBN 0-13-703515-2

e-Books :

- <https://ebookpdf.com/roger-s-pressman-software-engineering>
- <https://dhomaseghanshyam.files.wordpress.com/2016/02/gomaa-softwaremodellanddesign.pdf>
- <https://balu051989.files.wordpress.com/2011/06/the-unified-modeling-language-user-guide-by-grady-booch-james-rumbaugh-ivar-jacobson.pdf>
- [http://index-of.co.uk/Engineering/Software%20Engineering%20\(9th%20Edition\).pdf](http://index-of.co.uk/Engineering/Software%20Engineering%20(9th%20Edition).pdf)

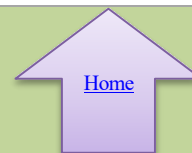
MOOCs Courses link

- <https://nptel.ac.in/courses/106/105/106105224/>
- https://onlinecourses.nptel.ac.in/noc20_cs59/preview
- https://onlinecourses.nptel.ac.in/noc20_cs84/preview

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Science (2019 Course)
310255: Internship**

**Teaching Scheme:**********Credit: 04****Examination Scheme:****Term-Work (TW): 100 Marks****Course Objectives:**

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

- To encourage and provide opportunities for students to get professional/personal experience through internships.
- To learn and understand real life/industrial situations.
- To get familiar with various tools and technologies used in industries and their applications.
- To nurture professional and societal ethics.
- To create awareness of social, economic and administrative considerations in the working environment of industry organizations.

Course Outcomes:

On completion of the course, learners should be able to

CO1: To demonstrate professional competence through industry internship.

CO2: To apply knowledge gained through internships to complete academic activities in a professional manner.

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

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

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

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

**** Guidelines:**

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

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

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

Duration:

Internship is to be completed after semester 5 and before commencement of semester 6 of at least 4 to 6 weeks; and it is to be assessed and evaluated in semester 6.

Internship work Identification:

Student may choose to undergo Internship at Industry/Govt. Organizations/NGO/MSME/Rural Internship/ Innovation/IPR/Entrepreneurship. Student may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/NGO's/Government

organizations/Micro/Small/ Medium enterprises to make themselves ready for the industry [1].

Students must register at Internshala [2]. Students must get Internship proposals sanctioned from college authority well in advance. Internship work identification process should be initiated in the Vth semester in coordination with training and placement cell/ industry institute cell/ internship cell. This will help students to start their internship work on time. Also, it will allow students to work in vacation period after their Vth semester examination and before academic schedule of semester VI. Student can take internship work in the form of the following but not limited to:

Working for consultancy/ research project,

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

Learning at Departmental Lab/Tinkering Lab/ Institutional workshop,

Development of new product/ Business Plan/ registration of start-up,

Industry / Government Organization Internship,

Internship through Internshala,

In-house product development, intercollegiate, inter department research internship under research lab/group, micro/small/medium enterprise/online internship,

Research internship under professors, IISC, IIT's, Research organizations,

NGOs or Social Internships, rural internship,

Participate in open source development.

Internship Diary/ Internship Workbook:

Students must maintain Internship Diary/ Internship Workbook. The main purpose of maintaining diary/workbook is to cultivate the habit of documenting. The students should record in the daily training diary the day-to-day account of the observations, impressions, information gathered and suggestions given, if any. The training diary/workbook should be signed every day by the supervisor. Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.

Internship Work Evaluation:

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

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

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

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

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

Depth of knowledge and skills: Communication and Presentation Skills

Team Work

Creativity

Planning and Organizational skills

Adaptability

Analytical Skills

Attitude and Behavior at work

Societal Understanding

Ethics

Regularity and punctuality

Attendance record

Diary/Work book

Student's Feedback from External Internship Supervisor

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

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

Proper and timely documented entries

Adequacy & quality of information recorded

Data recorded

Thought process and recording techniques used

Organization of the information

The report shall be presented covering following recommended fields but limited to,

Title/Cover Page

Internship completion certificate

Internship Place Details- Company background-organization and activities/Scope and object of the study / Supervisor details

Index/Table of Contents

Introduction

Title/Problem statement/objectives

Motivation/Scope and rationale of the study

Methodological details

Results / Analysis /inferences and conclusion

Suggestions / Recommendations for improvement to industry, if any

Attendance Record

Acknowledgement

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

Feedback from internship supervisor(External and Internal)

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

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

Reference:

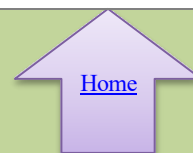
[1] <https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf>

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

@The CO-PO Mapping Matrix

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

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



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

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

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Set of suggested assignment list is provided in groups- A and B. Each student must perform 13 assignments (10 from group A, 3 from group B), 2 mini project from Group C

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

Programming tools recommended: - JAVA/Python/R/Scala

Virtual Laboratory:

- ["Welcome to Virtual Labs - A MHRD Govt of india Initiative"](#)
- <http://cse20-iiith.vlabs.ac.in/List%20of%20Experiments.html?domain=Computer%20Science>

Suggested List of Laboratory Experiments/Assignments

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

Sr. No.	Group A : Data Science
1.	<p>Data Wrangling, I</p> <p>Perform the following operations using Python on any open source dataset (e.g., data.csv)</p> <ol style="list-style-type: none"> 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 dataframe. 4. Data Preprocessing: check for missing values in the data using pandas isnull(), describe() function to get some initial statistics. Provide variable descriptions. Types of variables etc. Check the dimensions of the data frame. 5. Data Formatting and Data Normalization: Summarize the types of variables by checking the data types (i.e., character, numeric, integer, factor, and logical) of the variables in the data set. If variables are not in the correct data type, apply proper type conversions. 6. Turn categorical variables into quantitative variables in Python. <p>In addition to the codes and outputs, explain every operation that you do in the above steps and explain everything that you do to import/read/scrape the data set.</p>
2.	<p>Data Wrangling II</p> <p>Create an “Academic performance” dataset of students and perform the following operations using Python.</p> <ol style="list-style-type: none"> 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. <p>Reason and document your approach properly.</p>

3.	<p>Descriptive Statistics - Measures of Central Tendency and variability</p> <p>Perform the following operations on any open source dataset (e.g., data.csv)</p> <ol style="list-style-type: none"> 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. <p>Provide the codes with outputs and explain everything that you do in this step.</p>
4.	<p>Data Analytics I</p> <p>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.</p> <p>The objective is to predict the value of prices of the house using the given features.</p>
5.	<p>Data Analytics II</p> <ol style="list-style-type: none"> 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.	<p>Data Analytics III</p> <ol style="list-style-type: none"> 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.	<p>Text Analytics</p> <ol style="list-style-type: none"> 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.	<p>Data Visualization I</p> <ol style="list-style-type: none"> 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.	<p>Data Visualization II</p> <ol style="list-style-type: none"> 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.	<p>Data Visualization III</p> <p>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:</p> <ol style="list-style-type: none"> 1. List down the features and their types (e.g., numeric, nominal) available in the dataset. 2. Create a histogram for each feature in the dataset to illustrate the feature distributions. 3. Create a boxplot for each feature in the dataset. 4. Compare distributions and identify outliers.
	Group B- 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 MapReduce 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 <ol style="list-style-type: none"> 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 d. 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) <ul style="list-style-type: none"> • HDFS: Hadoop Distributed File System • YARN: Yet Another Resource Negotiator • MapReduce: Programming based Data Processing • Spark: In-Memory data processing • PIG, HIVE: Query based processing of data services • HBase: NoSQL Database (Provides real-time reads and writes) • Mahout, Spark MLlib: (Provides analytical tools) Machine Learning algorithm libraries • Solar, Lucene: Searching and Indexing

Reference Books :

1. Chirag Shah, "A Hands-On Introduction To Data Science", Cambridge University Press,(2020), ISBN : ISBN 978-1-108-47244-9.
2. Wes McKinney, "Python for Data Analysis", O'Reilly media, ISBN : 978-1-449-31979-3.
3. "Scikit-learn Cookbook", Trent hauk, Packt Publishing, ISBN: 9781787286382
4. R Kent Dybvig, "The Scheme Programming Language", MIT Press, ISBN 978-0-262-51298-5.
5. Jenny Kim, Benjamin Bengfort, "Data Analytics with Hadoop", O'Reilly Media, Inc.
6. Jake VanderPlas, "Python Data Science Handbook"
<https://tanthiamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf>
7. Gareth James, "An Introduction to Statistical Learning"
<https://www.ime.unicamp.br/~dias/Intoduction%20to%20Statistical%20Learning.pdf>
8. Cay S Horstmann, "Scala for the Impatient", Pearson, ISBN: 978-81-317-9605-4,
9. Alvin Alexander, "Scala Cookbook", O'Reilly, SPD, ISBN: 978-93-5110-263-2

References :

- <https://www.simplilearn.com/data-science-vs-big-data-vs-data-analytics-article>
- <https://hadoop.apache.org/docs/current/hadoop-mapreduce-client/hadoop-mapreduce-client-core/MapReduceTutorial.html>
- <https://www.edureka.co/blog/hadoop-ecosystem>
- https://www.edureka.co/blog/mapreduce-tutorial/#mapreduce_word_count_example
- <https://github.com/vasanth-mahendran/weather-data-hadoop>
- <https://spark.apache.org/docs/latest/quick-start.html#more-on-dataset-operations>
- <https://www.scala-lang.org/>

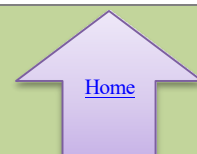
MOOCs Courses link:

- <https://nptel.ac.in/courses/106/106/106106212/>
- https://onlinecourses.nptel.ac.in/noc21_cs33/preview
- <https://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	2	2	2	2	-	-	-	-	3	-
CO2	2	2	2	2	3	-	-	-	-	-	-	-
CO3	2	2	2	-	2	-	-	-	-	-	-	-
CO4	2	2	2	2	2	2	-	-	-	-	-	-
CO5	2	2	2	2	2	2	-	-	-	-	-	-
CO6	2	2	2	2	2	2	-	-	-	-	-	-
CO7	2	2	2	2	3	2	-	-	-	-	-	-
CO8	2	2	2	2	3	2	-	-	-	-	3	-

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



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

Course Objectives:

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

Course Outcomes:

On completion of the course, learners will be able to

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

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Oral examination should be jointly conducted by the internal examiner and external examiner. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals, effective and efficient implementations in term work. This will encourage, transparent evaluation and fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.

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The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. Use of open source software is encouraged. Based on the concepts learned. Mini project should be implemented by

the students in a group of 2-3 students.

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

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

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.

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CO1	-	1	3	1	-	1	1	-	-	1	-	-
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CO4	1	2	2	1	2	1	1	-	-	-	-	1

SavitribaiPhule Pune University
Third Year of Computer Science (2019 Course)
310558: Laboratory Practice IV



Teaching Scheme Practical: 04 Hours/Week	Credit Scheme 02	Examination Scheme and Marks Term Work: 50 Marks Practical: 25 Marks
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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 / Advanced TCP/IP/Cloud Computing/Software Modeling and Architectures

Course Outcomes:

On completion of the course, learner will be able to

- **Artificial Intelligence**

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

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

CO3: Design and develop an expert system

- **Information Security**

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

CO5: Use the knowledge of security for problem solving

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

OR

- **Advanced TCP/IP**

CO4: Students will be able to understand and implement Client-Server models, perform socket programming for data communication, and apply BOOTP, DHCP, and other network protocols for efficient IP address allocation and data exchange.

CO5: Students will be able to demonstrate proficiency in application layer protocols by effectively configuring and managing FTP, SMTP, HTTP, TELNET, and Rlogin, including their operations, message formats, and remote system access.

CO6: Students will be able to understand and apply DNS and VoIP protocols, perform domain name resolution, analyze the impact of DNS caching on performance, and utilize RTP and RSVP operations for efficient real-time communication.

OR

- **Cloud Computing**

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

CO5: Use the knowledge of Cloud Computing for problem solving

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

OR

- **Software Modeling and Architectures**

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

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

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

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Operating System recommended :- 64-bit Windows OS and Linux Programming

tools recommended: -

Information Security : - C/C++/Java

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: <ul style="list-style-type: none"> 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	
6.	Implement any one of the following Expert System <ul style="list-style-type: none"> 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 Diffie-Hellman Key Exchange mechanism using HTML and JavaScript. Consider the end user as one of the parties (Alice) and the JavaScript application as other party (bob).
7.	Calculate the message digest of a text using the MD5 algorithm in JAVA.
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 Salesforce Cloud.
5.	<p style="text-align: center;">Mini-Project</p> <p>Setup your own cloud for Software as a Service (SaaS) over the existing LAN in your laboratory. In this assignment you have to write your own code for cloud controller using open-source technologies to implement 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.</p>
	Advanced TCP/IP Laboratory (All assignments are compulsory)
1.	Configuring a DHCP server using cisco packet tracer tool or any other packet tracer tool
2.	Write the program in python language for implementing the IP Routing, protocol using Address tables.
3.	Write the program in C language for implementing address resolution using DNS tables
4.	Write a program TELNET to establish a TCP connection to a specified host.
5.	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.
6.	Study and Analyze the performance of HTTP, HTTPS and FTP protocol using Packet tracer tool.
	Software Modeling and Architectures (Problem statement 1, 2 , 3 or 4, Problem statement 5 and 6 are mandatory)
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.	<p>Consider online shopping system. Perform the following tasks and draw the class diagram using UML tool.</p> <p>Represent the individual classes, and objects</p> <p>Add methods</p> <p>Represent relationships and other classifiers like interfaces</p>
3.	Consider the online shopping system in the assignment 2. Draw the sequence diagram using UML tool to show message exchanges
4.	<p>Consider your neighboring travel agent from whom you can purchase flight tickets. To book a ticket you need to provide details about your journey i.e., on which date and at what time you would like to travel. You also need to provide your address. The agency has recently been modernized. So, you can pay either by cash or by card. You can also cancel a booked ticket later if you decide to change your plan. In that case you need to book a new ticket again. Your agent also allows you to book a hotel along with flight ticket. While cancelling a flight ticket you can also cancel hotel booking. Appropriate refund as per policy is made in case of cancellation. Perform the following tasks and draw the use case diagram using UML tool.</p> <ol style="list-style-type: none"> Identify the use cases from a given non-trivial problem statement. Identify the primary and secondary actors for a system. Use to generalization of use cases and «include» stereotypes to prevent redundancy in the coding phase

Mini-Projects

5. Select a moderately complex system and narrate concise requirement Specification for the same. Design the system indicating system elements organizations using applicable architectural styles and design patterns with the help of a detailed Class diagram depicting logical architecture. Specify and document the architecture and design pattern with the help of templates. Implement the system features and judge the benefits of the design patterns accommodated.

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

Advanced TCP/IP

1. Douglas Comer, Internetworking with TCP/IP, Principles, Protocols and Architecture, Volume 1, Pearson Education Asia
2. Behrouz A. Forouzan, Data Communication and Networking, McGraw Hill Education, ISBN: 978-1-25-906475-3, 5th Edition

Software Modelling and Architectures

1. Jim Arlow, Ila Neustadt, “UML 2 and the unified process –practical object-oriented analysis and design”, Addison Wesley, Second edition, ISBN 978-0201770605
2. Len Bass, Paul Clements, Rick Kazman, "Software Architecture in Practice", Second Edition, Pearson ,ISBN 978-81-775-8996-2
3. Hassan Gomaa, “Software Modeling and Design- UML, Use cases, Patterns and Software Architectures”, Cambridge University Press, 2011, ISBN 978-0-521-76414-8
4. Erich Gamma, “Design Patterns”, Pearson, ISBN 0-201-63361-2

Reference Books:

1. Nilsson Nils J , “Artificial Intelligence: A new Synthesis”, Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4
2. Patrick Henry Winston, “Artificial Intelligence”, Addison-Wesley Publishing Company, ISBN: 0-201-53377-4
3. Andries P. Engelbrecht, “Computational Intelligence: An Introduction”, 2nd Edition-Wiley India- ISBN: 978-0-470-51250-0

Information Security

4. William Stallings, Lawrie Brown, “Computer Security Principles and Practice”, 3rd_Edition, Pearson
5. William Stallings, “Cryptography and Network Security Principals and Practice”, Fifth edition, Pearson
6. Nina Godbole, Sunit Belapure, “Cyber Security”, Wiley, ISBN: 978-81-265-2179-1

Advanced TCP/IP

7. Andrew S. Tanenbaum, David J. Wethrall, Computer Network, Pearson Education, ISBN: 978-0-13-212695-3

8. Kurose Ross, Computer Networking: A Top Down Approach Featuring the Internet, Pearson Education, ISBN: 978-81-7758-878-1
9. Behrouz A. Forouzan, TCP/IP Protocol Suite, McGraw Hill Education, ISBN: 978-0-07-070652-1, 4th Edition
10. Mayank Dave, Computer Network, Cengage Learning, ISBN: 978-81-315-0986-9

Cloud Computing

11. James Bond, "The Enterprise Cloud", O'Reilly Media, Inc. ISBN: 9781491907627
12. Dr. Kris Jamsa, "Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more", Wiley Publications, ISBN: 978-0-470-97389-9
13. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach", 2010, The McGraw-Hill.

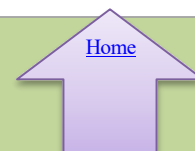
Software Modelling and Architectures

14. Gardy Booch, James Rumbaugh, Ivar Jacobson, "The unified modeling language user guide", Pearson Education, Second edition, 2008, ISBN 0-321-24562-8.
15. 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	PO10	PO11	PO12
CO1	2	-	2	-	3	-	-	2	2	2	1	2
CO2	1	-	2	2	3	2	-	2	2	2	1	2
CO3	1	-	2	2	3	2	-	2	2	2	2	2
CO4	1	-	2	-	3	-	-	2	2	2	2	2
CO5	1	-	2	-	3	-	-	2	2	2	2	2
CO6	1	-	2	-	3	-	-	2	2	2	2	2

Savitribai Phule Pune University
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):

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

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

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

Audit Course 6 Options

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

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

AC6-I Digital and Social Media Marketing**Prerequisites:** Internet Technologies**Course Objectives:**

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

Course Outcomes:

On completion of the course, learners will be able to

CO1: Understand the fundamentals and importance of digital marketing

CO2: Use the power of social media for business marketing

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

Course Contents

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

Reference Books :

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

@The CO-PO Mapping Matrix

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

AC6-II Sustainable Energy Systems**Prerequisites:** General awareness of environment and natural resources of energy**Course Objectives:**

- To understand the importance of sustainable energy systems development
- To create awareness about renewable energy sources and technologies
- To learn about adequate inputs on a variety of issues in harnessing renewable energy
- To recognize current and possible future role of renewable energy sources

Course Outcomes:

On completion of the course, learners will be able to

CO1: Comprehend the importance of Sustainable Energy Systems**CO2:** Correlate the human population growth and its trend to the natural resource degradation and develop the awareness about his/her role towards Sustainable Energy Systems protection**CO3:** Identify different types of natural resource pollution and control measures**CO4:** Correlate the exploitation and utilization of conventional and non-conventional resources**Course Contents**

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

Reference Books :

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

@The CO-PO Mapping Matrix

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

AC6-III Leadership and Personality Development**Prerequisites:** General awareness of communication and relationship.**Course Objectives:**

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

Course Outcomes:

On completion of the course, learners will be able to

CO1: Express effectively through communication and improve listening skills**CO3:** Develop effective team leadership abilities.**CO4:** Explore self-motivation and practicing creative/new age thinking.**CO5:** Operate effectively in heterogeneous teams through the knowledge of team work, people skills and leadership qualities.**Course Contents****1. Communication :**

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

2. Teamwork and People Skills :

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

3. New-age Thinking :

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

4. Self-Awareness :

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

Reference Books :

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

@The CO-PO Mapping Matrix

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

AC6-IV: Foreign Language (Japanese) Module 4

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

Course Objectives:

- To open up more doors and job opportunities
- To introduce to Japanese society, culture and entertainment

Course Outcomes:

On completion of the course, learner will be able to

CO1: Have the ability to communicate confidently and clearly in the Japanese language

CO2: Understand the nature of Japanese script

C03: Get introduced to reading, writing and listening skills

C04: Develop interest to pursue further study, work and leisure

Course Contents

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

Reference Books :

1. Minna No Nihongo, “Japanese for Everyone”, Elementary Main Text book1-1 (Indian Edition), Goyal Publishers and Distributors Pvt.Ltd.
2. <http://www.tcs.com> (http://www.tcs.com/news_events/press_releases/Pages/TCS-Inaugurates-Japan-centric-Delivery-Center-Pune.aspx)
3. Kazuko Karasawa, Mikiko Shibuya, “Nihongo Challenge N4 N5 Kannji Tomoko Kigami”, ISBN-10 4872177576, Ask Publishing Co.,Ltd.

@The CO-PO Mapping Matrix

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

AC6-V: MOOC- Learn New Skills**Prerequisites:** Software Engineering (210253)**Course Objectives:**

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

Course Outcomes:

On completion of the course, learner will be able to

CO1: Illustrate the agility and principles**CO2:** Understand the software development using agile methodology**CO3:** Apply DevOps for the software product development**CO4:** Develop software products for early delivery through continual feedback and learning**Course Contents**

1. **THE THREE WAYS :** Agile, continuous delivery and the three ways, The First Way: The Principles of Flow, The Second Way: The Principle of Feedback, The Third Way: The Principles of Continual Learning.
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 operation can safely deploy code, Integrate hypothesis-driven development and A/B testing into our daily work, Create review and coordination processes to increase quality of our current work.
5. **THE THRID 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, Petrick Debois, "The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations"
2. Len Bass, Ingo Weber, Liming Zhu, "DevOps: A Software Architect's Perspective " Publisher(s): Addison-Wesley Professional, ISBN: 9780134049885

@The CO-PO Mapping Matrix

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

Acknowledgement

It is with great pleasure and honor that I share the curriculum for Third Year of Computer Science (2019 Course) on behalf of Board of Studies (BoS), Computer Science. We, members of BoS are giving our best to streamline the processes and curricula design at both UG and PG programs.

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

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

Even in these anxious situations, during the time of this unfortunate pandemic, each and every person, including the course coordinators and their team members, have worked seamlessly to come up with this all-inclusive curriculum for Third Year of Computer Science. Thank you to all of you for delivering such great teamwork.

I don't think it would have been possible to achieve the goal without each and every one of your efforts! I would like to express my deep gratitude to Dr. Ujalambkar Deepali Milind, member BoS, Computer Science, for coordinating the complete activity and getting it to completion in a smooth manner.

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

I sincerely appreciate, the hard work put in by the course coordinators and their team members, without your intellectual work and creative mind, and it would have not been possible to complete this draft. Special thanks are due to Dr. Sachin R. Sakhare, Dr. Vaishali V. Vikhe, Dr. Dhananjay B. Kshirsagar, Dr. Amol D. Potgantwar, Dr. Sachin D. Babar, Dr. Vandana Dhingra, Dr. Balwant A. Sonkamble, Dr. Dipti D. Patil, Dr. Pradip M. Jawandhiya, Dr. Suhasini A. Itkar, Dr. Dipak V. Patil, Dr. Sandip G. Deshmukh for helping with the formatting and crisp presentation of this draft. I would like to thank you from the core of my heart. Thank you for always being your best selves and contributing to the work.

I am thankful to Prof. Dasganu Hakke 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!

Dr. Nilesh Uke

Chairman, Board of Studies (BoS),

Computer Science, Faculty of Science and Technology, Savitribai Phule Pune University.

Task Force at Curriculum Design

1. Advisors, the Team of Board of Studies-

Dr. Nilesh J. Uke (Chairman)	Dr. Amol D. Potgantwar	Dr. Sachin D. Babar
Dr. Pramod D. Patil	Dr. Vandana Dhingra	Dr. Deepali M. Ujalambkar
Dr. Sachin R. Sakhare	Dr. Balwant A. Sonkamble	Dr. Dipti D. Patil
Dr. Vaishali V. Vikhe	Dr. Pradip M. Jawandhiya	Dr. Suhasini A. Itkar
Dr. Dhananjay B. Kshirsagar	Dr. Dipak V. Patil	Dr. Sandip G. Deshmukh

2. Team Leader- Dr. Deepali M. Ujalambkar

3. Compiled By: Prof. Dasganu G. Hakke

4. Teams, Course Design-

Name of Course	Team Coordinators	Team Members	
Database Management Systems	Dr. Anuradha Thakare	Dr. Sarika Nitin Zaware Dr. S. B. Tambe Prof. Ranjit M. Gawande	Prof. Rahul Patil Prof. Prashant Ahire Dr. Sharmila Wagh
Theory of Computation	Dr. Sunil Dhore	Dr. Santosh Chobe Dr. Jyoti Rao Dr. G. R. Shinde Mr. Tushar Samnerkar (Industry)	Dr. Vaishali Tidake Prof. Anita Shinde Mr. Vivek Kulkarni (Industry)
Systems Programming and Operating Systems	Dr. Manisha Bhende	Dr. R. A. Satao Prof. Rupesh Mahajan Prof. Mrs. B. Mahalakshmi Prof. Mrs. Neelam Patil	Dr. V. S. Pawar Prof. S. R. Pandit Prof. Mrs. Dhanashree Patel
TCP/IP Networking	Prof. Dasganu G. Hakke	Dr. Vinod V. Kimbahune, Dr. Yogesh Gurav, Dr. S P Kosbatwar, Prof. Balasaheb Gite,	Prof. Prajwal Gaikwad, Dr. Megha Kadam, Dr. Mangesh D. Salunke Prof. Nagesh Patil
Elective I: Internet of Things and Embedded Systems	Dr. A. B. Pawar	Dr. Sandeep Chaware Dr. M. S. Chaudhari Dr. M. P. Wankhade	Mr. Rajnikant (Industry) Mr. Mahesh Aher (Industry)
Elective I: Human Computer Interface	Dr. S. D. Babar	Prof. Mrs. G. J. Chhajed Prof. D. D. Sapkal Prof. Mrs. Jayshree R. Pansare Mr. Mukesh Jain (Industry) Prof. Mrs. Shailaja N. Lohar	Prof. S. A. Thanekar Dr. Deepak Dharrao Dr. Ganesh Bhutkar Mr. Himmat Sankhala (Industry)
Elective I: Distributed System	Dr. Amar Buchade	Prof. Rajesh Bharati Dr. Suresh V. Limkar Mr. Pratik Dixit (Industry)	Dr. Swati A. Bhavsar Dr. Sonali Patil Dr. Rachna Somkunwar Mr. Vijay Bahiraji (Industry)
Elective I: Software Project Management	Dr. Sachin Sakhare	Dr. R. L. Paikrao Prof. Santosh Sambare Prof. Pimpalkar S. P.	Prof. Shinde Sushma S Prof. Mrs. Vina M Lomte Mr. Prashant Pund (Industry) Mr. Shekhar Dhupkar (Industry)
Database Management System Laboratory	Prof. Rahul Patil	Prof. Rajesh Bharati	Nitin Ghadage (Industry)
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Laboratory Practice III	Prof. Dasganu G. Hakke	Dr. Vinod V. Kimbahune, Dr. Yogesh Gurav, Dr. S P Kosbatwar, Prof. Balasaheb Gite,	Prof. Prajwal Gaikwad, Dr. Megha Kadam, Dr. Mangesh D. Salunke Prof. Nagesh Patil
Seminar	Dr. Swati A. Bhavsar		

Audit Course 5	Dr. Kishor Wagh	Dr. S. S. Das Dr. D. V. Patil	Dr. Sandeep Patil Dr. Bendre Mr. B. B. Gite
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. Amod Vaidya (Industry)	Dr. B. D. Phulpagar Dr. K. V. Metre Mr. Atul Bengeri (Industry) Mr. Summer Patil (Industry) Mr. Sanjeev Kumar (Industry)
Web Technology	Prof. Abhijit D. Jadhav	Prof. Jayvant Devare	Mr. Avinash Patil (Industry) Mr. Saikrishna Mamidishetty (Industry)
Artificial Intelligence	Dr. J. R. Prasad	Dr. Gayatri M. Bhandari Dr. V. P. Vikhe Dr. Snehal Mohan Kamalapur	Dr. K Rajeswari Dr. Mrs. Madhuri Potey
Elective II: Information Security	Dr. Swati Nikam	Dr. Pathan Mohd Shafi Dr. Mininath Nighot Dr. Ms. K.C. Nalavade	Dr. Lomte Archana C. Dr. Amol Potgantwar Mr. Akshay Kokil (Industry)
Elective II: Advanced TCP/IP	Dr. Megha Kadam	Dr. Vinod V. Kimbahune, Dr. Yogesh Gurav, Dr. S P Kosbatwar, Prof. Balasaheb Gite,	Prof. Prajwal Gaikwad, Dr. Megha Kadam, Dr. Mangesh D. Salunke Prof. Nagesh Patil
Elective II: Cloud Computing	Dr. S. K. Sonkar	Prof. Abhijit D. Jadhav Dr. Pankaj Agarkar Dr. N. M. Ranjan	Dr. A. S. Rumale Prof. Thombre B. H. Mr. Ashok Pomnar (Industry) Mr. Santosh Ugale (Industry)
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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. Amod Vaidya (Industry)	Dr. B. D. Phulpagar Dr. K. V. Metre Mr. Atul Bengeri (Industry) Mr. Summer Patil (Industry) Mr. Sanjeev Kumar (Industry)
Web Technology Laboratory	Prof. Abhijit D. Jadhav	Mr. Avinash Patil (Industry)	Mr. Saikrishna Mamidishetty (Industry)
Laboratory Practice IV	Prof. Dasganu G. Hakke	Dr. Vinod V. Kimbahune, Dr. Yogesh Gurav, Dr. S P Kosbatwar, Prof. Balasaheb Gite,	Prof. Prajwal Gaikwad, Dr. Megha Kadam, Dr. Mangesh D. Salunke Prof. Nagesh Patil
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