Faculty of Science and Technology

Savitribai Phule Pune University
Maharashtra, India

http://unipune.ac.in

Curriculum
for

Third Year
Computer Science and Design
(2021 Course)

(With effect from 2023-24)

Third Year of Computer Science and Design
(2021 Course)
(With effect from 2023-24)

Prologue

It is my great pleasure and honor to share the syllabi for Third Year of Computer Science and Design (2021 Course) on behalf of Board of Studies, Computer Engineering. We, members of BoS have tried our best to streamline the processes and curricula design with the help of faculty members and industry experts.

While revising syllabus, honest and sincere efforts are put to tune Computer Science and Design program syllabus in tandem with the objectives of NEP, Higher Education of India, AICTE, UGC and affiliated University (SPPU) by keeping an eye on the technological advancements and industrial requirements globally. Syllabus revision is materialized with sincere efforts, active participation, expert opinions and suggestions from domain professionals. Sincere efforts have been put by members of BoS, teachers, alumni, industry experts in framing the draft with guidelines and recommendations.

Case Studies are included in almost all courses. Course Instructor is recommended to discuss appropriate related recent technology/upgrade/Case Studies to encourage students to study from course to the scenario and think through the largest issues/ recent trends/ utility/ developing real world/ professional skills.

I am beholder to all the minds and hands who have worked adroitly to execute these tasks. I am highly appreciative of your contributions and suggestions given to this content.

With Regards,

Dr. Nilesh J. Uke

Chairman Board of Studies (Computer Engineering), SPPU, Pune

links for First- and Second-Year Computer Science and Design Curriculum 2019:

1. http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/Rules%20and%20Regulations%20F.E.%202019%20Patt_10.012020.pdf
2. http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/First%20Year%20Engineering%202019%20Patt.Syllabus_05.072019.pdf
3. http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2022/SE%20CSD%20Syllabus31032023.pdf

Savitribai Phule Pune University

Third Year of Computer Science and Design (2021 Course)

(With effect from Academic Year 2023-24)

Table of Contents

Savitribai Phule Pune University

Third Year of Computer Science and Design

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 modelling to complex Engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practices.
PO7	**Environment and Sustainability**	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of Engineering practice.
PO9	**Individual and Team Work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication Skills**	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project Management and Finance**	Demonstrate knowledge and understanding of Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments.
PO12	**Life-long Learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

A graduate of the Computer Science and Design Program will demonstrate-

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

Savitribai Phule Pune University

Third Year of Computer Science and Design (2021 Course)

(With effect from Academic Year 2023-24)

Semester-V

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	In-Sem	End-Sem	Term work	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
318241	Software Engineering and Project Management	03	-	-	30	70	-	-	-	100	03	--	-	03
318242	Theory of Computation	03	-	-	30	70	-	-	-	100	03	-	-	03
318243	Database System Design	03	-	-	30	70	-	-	-	100	03	-	-	03
318244	Design and analysis of Algorithm	03	-	-	30	70	-	-	-	100	03	-	-	03
318245	Elective – I	03	-	-	30	70	-	-	-	100	03	-	-	03
318246	Database System Design Laboratory	-	04	-	-	-	25	25	-	50	-	02	-	02
318247	Design And Analysis of algorithm Laboratory	-	02	-	-	-	25	25	-	50	-	01	-	01
318248	Laboratory Practice I	-	02	-	-	-	25	-	25	50	-	01	-	01
318249	Seminar and Technical Communication	-		01	-	-	25	-	-	25	-	-	01	01
318250	Environmental Studies	-	-	01	-	-	25	-	-	25	-	-	01	01
	Total	**15**	**08**	**02**	**150**	**350**	**125**	**50**	**25**	**700**	**15**	**04**	**02**	**21**
310250	Audit Course 5										**Grade**			
										Total	**15**	**04**	**02**	**21**

**** Elective-I Options**

318245A: Internet of Things
318245B: Pattern Recognition
318245C: Distributed Systems
318245D: Data Mining and warehousing

Audit Course 5 Options

310250A: Cyber Security
310250B: Professional Ethics and Etiquettes
310250C: MOOC- Learn New Skills
310250D: Engineering Economics
310250E: Foreign Language

Laboratory Practice I

Assignments are based on Elective I Theory Course

Savitribai Phule Pune University

Third Year of Computer Science and Design (2021 Course)

(With effect from Academic Year 2023-24)

Semester-VI

Course Code	Course Name	Teaching Scheme #(Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		#Lecture	Practical	Tutorial	In-Sem	End-Sem	Term work	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
318251	Artificial Intelligence	04	-	-	30	70	-	-	-	100	03	-	-	03
318252	Web Technology & Application Design	04	-	-	30	70	-	-	-	100	03	-	-	03
318253	UI/UX Design	04	-	-	30	70	-	-	-	100	03	-	-	03
318254	Elective – II	04	-	-	30	70	-	-	-	100	03	-	-	03
310255	Internship**	-	**	-	-	-	100	-	-	100	-	04	-	04
318255	Web Technology & Application Design Laboratory	-	04	-	-	-	50	-	25	75	-	02	-	02
318256	UI/UX design Laboratory	-	02	-	-	-	25	-	25	50	-	01	-	01
318257	Laboratory Practice II	-	04	-	-	-	50	25		75	-	02	-	02
	Total	**16**	**10**	**-**	**120**	**280**	**225**	**25**	**50**	**700**	**12**	**09**	**-**	**21**
310259	Audit Course 6										**Grade**			
									Total		**12**	**09**	**-**	**21**

318256 Elective II Options:

318254(A) Multimedia Techniques
318254(B) Augmented and Virtual Reality
318254(C) Cloud Computing
318254(D) Business Intelligence and Data Analytics

310259 Audit Course 6 Options:

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

Laboratory Practice II:
Assignments are based on Artificial Intelligence and Elective II Theory course

Internship** Internship guidelines are provided in course curriculum sheet.

General Guidelines

1. Every undergraduate program has its own objectives and educational outcomes. These objectives and outcomes are furnished by considering various aspects and impacts of the curriculum. These **Program Outcomes (POs)** are categorically mentioned at the beginning of the curriculum (ref: NBA Manual). There should always be a rationale and a goal behind the inclusion of a course in the curriculum. Course Outcomes though highly rely on the contents of the course; many-a-times are generic and bundled. The **Course Objectives**, **Course Outcomes** and **CO-PO mappings matrix** justifies the motives, accomplishment and prospect behind learning the course. The Course Objectives, Course Outcomes and CO-PO Mapping Matrix are provided for reference and these are indicative only. The course instructor may modify them as per his or her perspective.

2. @:**CO and PO Mapping Matrix**(Course Outcomes and Program Outcomes)- The **expected** attainment mapping matrix at end of course contents, indicates the correlation levels of 3, 2, 1 and '-'. The notation of 3, 2 and 1 denotes substantially (high), moderately (medium) and slightly (low). The mark '-'indicates that there is no correlation between the respective CO and PO.

3. **#:Elaborated examples/Case Studies-** For each course, contents are divided into six units-I, II, III, IV, V and VI. Elaborated examples/Case Studies are included at the end of each unit to explore how the learned topics apply to real world situations and need to be explored so as to assist students to increase their competencies, inculcating the specific skills, building the knowledge to be applicable in any given situation along with an articulation. One or two sample exemplars or case studies are included for each unit; instructor may extend the same with more. Exemplar/Case Studies may be assigned as self-study by students and to be excluded from theory examinations.

4. *****:For each unit contents, the desired content attainment mapping is indicated with Course Outcome(s). Instructor may revise the same as per their viewpoint.

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

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

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

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

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

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

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

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

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

13. UGC has issued the UGC (Credit Framework for online learning courses through SWAYAM) Regulation 2016 advising the Universities to identify courses where credits can be transferred on to the academic record of the students for courses done on SWAYAM. AICTE has also put out gazette notification in 2016 and subsequently for adoption of these courses for credit transfer[2].
SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity, and quality. This is done through a platform that facilitates hosting of the courses to be accessed by anyone, anywhere at any time. Courses delivered through SWAYAM are interactive, prepared by the best teachers in the country and are available, free of cost to any learner. However, learners wanting a SWAYAM certificate should register for the final proctored exams that come at a
fee and attend in-person at designated center on specified dates. Eligibility for the certificate is generally announced on the course page. Universities/colleges approving credit transfer for these courses can use the marks/certificate obtained in these courses for the same.[2]

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

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

Note: For Examination rules, pattern and assessment please refer[1]
[1]http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/Rules%20and%20Regulations%20F.E.%202019%20Patt_10.012020.pdf
[2] https://swayam.gov.in/about

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

Semester V

Savitribai Phule Pune University
Third Year of Computer Science and Design (2021 Course)

318241: Software Engineering and Project Management

Teaching Scheme Credit Scheme Examination Scheme and Marks	Credit Scheme 03 Mid_Semester(TH): 30 Marks	Examination Scheme and Marks
Lecture: 03Hours/Week Credit Scheme Examination Scheme and Marks	03 03 Mid_Semester(TH): 30 Marks	Mid Semester (TH): 30 Mark End Semester (TH): 70 Marks

Prerequisite Courses:

Course Objectives:

- To learn and understand the principles of Software Engineering
- To be acquainted with methods of capturing, specifying, visualizing and analysing software requirements.
- To apply Design and Testing principles to S/W project development.
- To understand project management through life cycle of the project.
- To understand software quality attributes.

Course Outcomes:

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

CO1: Decide on a process model for a developing a software project
CO2: Classify software applications and Identify unique features of various domains
CO3: Design test cases of a software system.
CO4: Understand basics of IT Project management.
CO5: Plan, schedule and execute a project considering the risk management.
CO6: Apply quality attributes in software development life cycle.

Course Contents

Unit I	Introduction to Software Engineering, Software Process Models	(07 Hours)

Software Engineering Fundamentals: Nature of Software, Software Engineering Principles, The Software Process, Software Myths. **Process Models :**A Generic Process Model, Prescriptive Process Models: The Waterfall, Incremental Process(RAD), Evolutionary Process, Unified Process, Concurrent. **Advanced Process Models & Tools:** Agile software development: Agile methods, Plan-driven and agile development, Extreme programming Practices, Testing in XP, Pair programming. Introduction to agile tools: JIRA, Kanban, Case Studies: An information system (mental health-care system), wilderness weather system

*Mapping of Course Outcomes for Unit 1	CO1

Unit II	Software Requirements Engineering & Analysis	(07 Hours)

Requirements Engineering: User and system requirements, Functional and non-functional requirements, Types & Metrics, A spiral view of the requirements engineering process. **Software Requirements Specification (SRS):** The software requirements Specification document, The structure of SRS, Ways of writing a SRS, structured & tabular SRS for an insulin pump case study, **Requirements elicitation & Analysis:** Process, Requirements validation, Requirements management. **Case Studies:** The information system.
Case study - Mental health care patient management system (MHC-PMS).

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

Unit III	**Design Engineering**	**07 Hours**

Design Process & quality, Design Concepts, The design Model, Pattern-based Software Design. **Architectural Design :**Design Decisions, Views, Patterns, Application Architectures, **Modeling Component level Design:** component, Designing class based components, conducting component-level design, **User Interface Design:** The golden rules, Interface Design steps & Analysis, Design Evaluation, **Case Study:** Web App Interface Design

***Mapping of Course Outcomes for Unit III**	CO1, CO3

Unit IV	**Project Management: Process, Metrics, Estimations & Risks**	**07 Hours**

Project Management Concepts: The Management Spectrum, People, Product, Process, Project, The W5HH Principle, Metrics in the Process and Project Domains, Software Measurement : size & function oriented metrics(FP & LOC), Metrics for Project and Software Quality, P**roject Estimation :**Observations on Estimation, Project Planning Process, Software Scope and feasibility, Resources: Human Resources, Reusable software, Environmental Resources. Software Project Estimation, Decomposition Techniques, Empirical Estimation Models: Structure, COCOMO II, Estimation of Object-oriented Projects, Specialized Estimation **Case Study:** Software Tools for Estimation, **Project Scheduling:** Basic Concepts, Defining a Task Set for the Software Project, Defining Task Network, Scheduling with time-line charts, Schedule tracking Tools:- Microsoft Project, Daily Activity Reporting & Tracking (DART)

***Mapping of Course Outcomes for Unit IV**	CO3, CO4

Unit V	**Project Management: Risk Management, Configuration Management, Maintenance & Reengineering**	**07 Hours**

Project Risk Management : Risk Analysis & Management: Reactive versus Proactive Risk Strategies, Software Risks, Risk Identification, Risk Projection, Risk Refinement, Risk Mitigation, Risks Monitoring and Management, The RMMM plan for case study project **Software Configuration Management :** The SCM repository, SCM process, Configuration management for WebApps, **Case study:** CVS and Subversion Tools, Visual Source Safe from Microsoft & Clear Case. **Maintenance & Reengineering:** Software Maintenance, Software Supportability, Reengineering, Business Process Reengineering, Software Reengineering, Reverse Engineering, Restructuring, Forward Engineering	
***Mapping of Course Outcomes for Unit V**	CO5, CO6

Unit VI	**Software Testing**	**07 Hours**
Introduction to Software Testing, Principles of Testing, Testing Life Cycle, Phases of Testing, Types of Testing, Verification & Validation, Defect Management, Defect Life Cycle, Bug Reporting, GUI Testing, Test Management and Automation.		
***Mapping of Course Outcomes for Unit VI**	CO5, CO6	

Learning Resources

Text Books:

1. Roger Pressman, "Software Engineering: A Practitioner's Approach", McGraw Hill, ISBN 0–07–337597–7
2. Ian Sommerville, " Software Engineering", Addison and Wesley, ISBN 0-13-703515-2

Reference Books:

1. Carlo Ghezzi, "Fundamentals of Software Engineering", Prentice Hall India, ISBN-10: 0133056996
2. Rajib Mall, "Fundamentals of Software Engineering", Prentice Hall India, ISBN-13: 978-8120348981
3. Pankaj Jalote, "An Integrated Approach to Software Engineering", Springer, ISBN 13: 9788173192715.
4. S K Chang, "Handbook of Software Engineering and Knowledge Engineering", World Scientific, Vol I, II, ISBN: 978-981-02-4973-1
5. Tom Halt, "Handbook of Software Engineering", Clanye International, ISBN-10: 1632402939

@The CO-PO Mapping Matrix

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

CO6	-	-	-	-	1	-	-	-	3	1	3	-

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Third Year of Computer Science and Design (2021Course)

318242: Theory of Computation

Teaching Scheme: **Examination Scheme:**

Prerequisites Courses: Discrete Mathematics (210241)

Companion Course:

Course Objectives:

- To introduce the students to basics of Theory of Computation
- To study Automata, Grammars and 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:

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 Push down 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

#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**
	End-Sem (TH):70 Marks
	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 Є-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**
	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	Algorithms using Turing Machine
***Mapping of Course Outcomes for Unit V**	CO5
Unit VI	**Computability and Complexity Theory** **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. **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)
***Mappingof Course Outcomes forUnit 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. JohnMartin,"IntroductiontoLanguagesandTheTheoryofComputation",2ndEdition, McGrawHillEducation,ISBN-13:978-1-25-900558-9,ISBN-10:1-25-900558-5

Reference Books:

1. SanjeevAroraandBoazBarak,"ComputationalComplexity:AModernApproach",Cam bridge University Press, ISBN: 05214242679780521424 2643.
2. Daniel Cohen, "Introduction to Computer Theory", Wiley & Sons, ISBN97881265133454.
3. J. Carroll & D Long, "Theory of Finite Automata", Prentice Hall, ISBN0-13-913708-45.
4. Kavi Mahesh, "Theory of Computation: A Problem-Solving Approach", Wiley India, ISBN1081265331106.
5. Michael Sipser, "Introduction to the Theory of Computation", Cengage Learning, ISBN-13:97811331878137.
6. Vivek Kulkarni, "Theory of Computation", Oxford University Press, ISBN 0-19-808458

e_books:

- https://cglab.ca/~michiel/TheoryOfComputation/TheoryOfComputation.pdf
- https://www.cs.virginia.edu/~robins/Sipser_2006_Second_Edition_Problems.pdf
- http://ce.sharif.edu/courses/9495/1/ce4142/resources/root/Text%20Books/Automata/John%20E.%20Hopcroft,%20Rajeev%20Motwani,%20Jeffrey%20D.%20UllmanIntroduction%20to%20Automata%20Theory,%20Languages,%20and%20Computations-Prentice%20Hall%20(2006).pdf

MOOCs Courses Links:

- https://npt el.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 and Design (2021 Course)

318243: Database System Design

Teaching Scheme Credit Scheme Examination Scheme and Marks	Credit Scheme 03 Mid_Semester(TH): 30 Marks	Examination Scheme and Marks
Lecture: 03 Hours/Week Credit Scheme Examination Scheme and Marks	03 03 Mid_Semester(TH): 30 Marks	Mid Semester (TH): 30 Mark End Semester (TH): 70 Marks

Prerequisite Courses : Discrete Mathematics (210241), Data Structures and Algorithms(218242), Data Structures and files(218253)

Companion Course : Database System Design Laboratory(318246)

Course Objectives:

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

Course Outcomes:

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

CO1: Analyze and design Database Management System using ER model
CO2: Implement database queries using database languages
CO3: Normalize the database design using normal forms
CO4: Apply Transaction Management concepts in real-time situations
CO5: Use NoSQL databases for processing unstructured data
CO6: Differentiate between Complex Data Types and analyze the use of appropriate datatypes

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 1**	CO1	
Unit II	**SQL and PL/SQL**	**(07 Hours)**
SQL: Characteristics and Advantages, SQL Data Types and Literals, DDL, DML, DCL, TCL, SQL Operators. **Tables**: Creating, Modifying, Deleting, Updating.**SQL DML Queries**: SELECT Query and clauses, Index and Sequence in SQL. **Views**: Creating, Dropping, Updating using Indexes, Set Operations, Predicates and Joins, Set membership, Tuple Variables, Set comparison, Ordering of Tuples, Aggregate Functions, SQL Functions, Nested Queries.**PL/SQL**: Concept of Stored Procedures and Functions, Cursors, Triggers, Assertions, Roles and Privileges.		
#Exemplar/Case Studies	Implementation of Unit 1 case study using SQL and PL/SQL.	

***Mapping of Course Outcomes for Unit II**	CO1, CO2	
Unit III	**Relational Database Design**	**06 Hours**
Relational Model: Basic concepts, Attributes and Domains, CODD's Rules. **Relational Integrity**: Domain, Referential Integrities, Enterprise Constraints. **Database Design**: Features of Good Relational Designs, Normalization, Atomic Domains and First Normal Form, Decomposition using Functional Dependencies, Algorithms for Decomposition, 2NF, 3NF,BCNF.		
#Exemplar/Case Studies	Normalize relational database designed in Unit I.	
***Mapping of Course Outcomes for Unit III**	CO1, CO3	
Unit IV	**Database Transaction Management**	**07 Hours**
Introduction to Database Transaction, Transaction states, ACID properties, Concept of Schedule, Serial Schedule. **Serializability**: Conflict and View, Cascaded Aborts, Recoverable and Non-recoverable Schedules. **Concurrency Control**: Lock-based, Time-stamp based Deadlock handling. **Recovery methods**: Shadow-Paging and Log-Based Recovery, Checkpoints. **Log-Based Recovery**: Deferred Database Modifications and Immediate Database Modifications.		
#Exemplar/Case Studies	Study of Transaction Management in Postgre SQL	
***Mapping of Course Outcomes for Unit IV**	CO3, CO4	
Unit V	**NoSQL Databases**	**07 Hours**

Introduction to Distributed Database System, Advantages, Disadvantages, CAP Theorem.**Types of Data:** Structured, Unstructured Data and Semi-Structured Data.**NoSQL Database:** Introduction, Need, Features. **Types of NoSQL Databases:** Key-value store, document store, graph, wide column stores, BASE Properties, Data Consistency model, ACID Vs BASE, Comparative study of RDBMS and NoSQL. **MongoDB** (with syntax and usage): CRUD Operations, Indexing, Aggregation, MapReduce, Replication, Sharding.		
#Exemplar/Case Studies	Use of NoSQL databases for processing unstructured data fromsocial 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 HillPublishers, ISBN 0-07-120413-X, 6th edition
2. Connally T, Begg C., "Database Systems", Pearson Education, ISBN 81-7808-861-4
3. Pramod J. Sadalage and Martin Fowler, “NoSQL Distilled”, Addison Wesley, ISBN-10: 0321826620, ISBN-13: 978-0321826626

Reference Books :

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

e-Books :

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

MOOCs Courses Links:

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

@ The CO-PO Mapping Matrix

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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 and Design (2021 Course)

318244: Design and Analysis of Algorithms

Teaching Scheme	Credit Scheme	Examination Scheme and Marks

Credit Scheme **Examination Scheme and Marks**	**03** **Mid_Semester(TH): 30 Marks**	
Lecture: 03 Hours/Week **Credit Scheme** **Examination Scheme and Marks**	**03** **03** **Mid_Semester(TH): 30 Marks**	**Mid Semester (TH): 30 Mark** **End Semester (TH): 70 Marks**

Prerequisite Courses : Discrete Mathematics (210241), Data Structures and Algorithms(218242), Data Structures and files(218253)

Companion Course : Design and Analysis of Algorithms Lab(318247)

Course Objectives:

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

Course Outcomes:

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

CO1: Formulate the problem
CO2: Analyze the asymptotic performance of algorithms
CO3: Decide and apply algorithmic strategies to solve given problem
CO4: Find optimal solution by applying various methods
CO5: Analyze and Apply Scheduling and Sorting Algorithms.
CO6: Solve problems for multi-core or distributed or concurrent environments

Course Contents

Unit I	**Algorithms and Problem Solving**	**(07 Hours)**

Algorithm: The Role of Algorithms in Computing - What are algorithms, Algorithms as technology, Evolution of Algorithms, Design of Algorithm, Need of Correctness of Algorithm, Confirming correctness of Algorithm – sample examples, Iterative algorithm design issues. Problem solving Principles: Classification of problem, problem solving strategies, classification of time complexities (linear, logarithmic etc.)

#Exemplar/Case Studies	Towers of Hanoi
***Mapping of Course Outcomes for Unit 1**	CO1,CO3

Unit II	**Analysis of Algorithms and Complexity Theory**	**(07 Hours)**

Analysis: Input size, best case, worst case, average case Counting Dominant operators, Growth rate, upper bounds, asymptotic growth, O, Ω, Θ, o and ω notations, polynomial and non-polynomial problems, deterministic and non-deterministic algorithms, P- class problems, NP-class of problems, Polynomial problem

reduction NP complete problems- vertex cover and 3-SAT and NP hard problem - Hamiltonian cycle.	
#Exemplar/Case Studies	Analysis of iterative and recursive algorithm
***Mapping of Course Outcomes for Unit II**	CO2

Unit III	Greedy And Dynamic Programming Algorithmic Strategy	(07 Hours)
Greedy strategy: Principle, control abstraction, time analysis of control abstraction, knapsack problem, scheduling algorithms-Job scheduling and activity selection problem. Dynamic Programming: Principle, control abstraction, time analysis of control abstraction, binomial coefficients, OBST, 0/1 knapsack, Chain Matrix multiplication		
#Exemplar/Case Studies	Rail tracks connecting all the cities	
***Mapping of Course Outcomes for Unit III**	CO3, CO4	
Unit IV	**Backtracking and Branch-n-Bound**	**(07 Hours)**
Backtracking: Principle, control abstraction, time analysis of control abstraction, 8-queen problem, graph coloring problem, sum of subsets problem. Branch-n-Bound: Principle, control abstraction, time analysis of control abstraction, strategies FIFO, LIFO and LC approaches, TSP, knapsack problem.		
#Exemplar/Case Studies	Airline Crew Scheduling	
***Mapping of Course Outcomes for Unit IV**	CO3, CO4	
Unit V	**Amortized Analysis**	**(07 Hours)**
Amortized Analysis: Aggregate Analysis, Accounting Method, Potential Function method, Amortized analysis-binary counter, stack Time-Space tradeoff, Introduction to Tractable and Non tractable Problems, Introduction to Randomized and Approximate algorithms, Embedded Algorithms: Embedded system scheduling (power optimized scheduling algorithm), sorting algorithm for embedded systems.		
#Exemplar/Case Studies	cutting stock problem	
***Mapping of Course Outcomes for Unit V**	CO3,CO5	
Unit VI	**Multithreaded And Distributed Algorithms**	**(07 Hours)**
Multithreaded Algorithms - Introduction, Performance measures, Analyzing multithreaded algorithms, Parallel loops, and Race conditions. Problem Solving using Multithreaded Algorithms - Multithreaded matrix multiplication, Multithreaded merge sort. Distributed Algorithms - Introduction, Distributed breadth first search, Distributed Minimum Spanning Tree. String Matching- Introduction, The Naive string-matching algorithm, The Rabin-Karp algorithm.		
#Exemplar/Case Studies	Plagiarism detection	
***Mapping of Course Outcomes for Unit VI**	CO6	

Learning Resources

Text Books:

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

Reference Books:

1. Michael T. Goodrich, Roberto Tamassia, Algorithm Design: Foundations,‖ Analysis and Internet Examples‖, Wiley, ISBN 978-81-265-0986-7
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms‖, MIT Press; ISBN 978-0-262-03384-8

3. Horowitz and Sahani, "Fundamentals of Computer Algorithms", University Press, ISBN: 978 817371 6126,817371 61262
4. Rajeev Motwani and Prabhakar Raghavan, Randomized Algorithms‖ Cambridge University Press, ISBN: 978-0-521-61390-3
5. Dan Gusfield, Algorithms on Strings, Trees and Sequences‖, Cambridge University Press,ISBN:0- 521-67035-7

eBooks:

1. https://www.tutorialspoint.com/design_and_analysis_of_algorithms/design_and_analysis_of_algorithms_tutorial.pdf
2. https://www.ebooks.com/en-in/book/1679384/algorithms-design-techniques-andanalysis/m-h-alsuwaiyel

@The CO-PO Mapping Matrix

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO1	1	2	-	-	-	-	-	-	-	-	-	2
CO2	2	3	-	-	-	-	-	-	-	-	-	2
CO3	2	3	2	-	-	-	-	-	-	-	-	3
CO4	2	3	3	2	-	-	-	-	-	-	-	3
CO5	2	2	2	2	-	-	-	-	-	-	-	3
CO6	2	2	1	2	-	-	-	-	-	-	-	-

Savitribai Phule Pune University
Third Year of Computer Science and Design (2021 Course)
Elective I
318245(A): Internet of Things

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

Prerequisites Courses: Computer Networks (218255)

Companion Course: Laboratory Practice I (318248)

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: Apply IoT enabling technologies for developing IoT systems
CO2: Apply design methodology for designing and implementing IoT applications
CO3: Analyze IoT protocols for making IoT devices communication
CO4: Design cloud based IoT systems
CO5: 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, MicrocontrollerProperties, 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 andActuators, 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 Architectureand 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, ThreatModeling. **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, CO5	

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 Introductionto 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

ebooks :

- 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

Savitribai Phule Pune University
Third Year of Computer Science and Design (2021 Course)
Elective I
318245B: Pattern Recognition

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

Prerequisite Courses, if any:

Companion Course, if any: Elective I Laboratory (318248)

Course Objectives:

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

Course Outcomes:

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

CO1: Distinguish variety of pattern recognition, classification and combination techniques.
CO2: Apply statistical pattern recognition approaches in variety of problems.
CO3: Elaborate different approaches of syntactic pattern recognition.
CO4: Differentiate graphical approach and grammatical inferences in syntactic pattern recognition.
CO5: Illustrate the artificial neural network-based pattern recognition
CO6: Apply unsupervised learning in pattern recognition.

Course Contents

Unit I	Introduction to Pattern Recognition	(07Hours)

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

#Exemplar/Case Studies	Black Box Approaches to Pattern Recognition
Mapping of Course Outcomes for Unit I	CO1

Unit II	Statistical Pattern Recognition	(07 Hours)

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

#Exemplar/Case Studies	statistical pattern recognition in image processing
Mapping of Course Outcomes for Unit II	CO2

Unit III	Syntactic Pattern Recognition	(07 Hours)

Overview, Qualifying structure in Pattern Description and Recognition, Grammar-Based Approach and Applications, Elements of Formal Grammars, Examples of String Generation as Pattern Description, Syntactic **Recognition Via Parsing and other Grammars**: -Recognition of Syntactic Descriptions, Parsing, CYK Parsing Algorithm, ATN in Parsing, Higher Dimensional Grammars, Stochastic Grammars and Applications.		
#Exemplar/Case Studies	Block World Description	
Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**Graphical Approaches & Grammatical Inference in Syntactic Pattern Recognition**	**(07 Hours)**
Graphical Approaches: Graph Based Structural Representation, Graph Isomorphism, A Structured Strategy to Compare Attribute Graphs, Other Attributed Graph Distance or Similarity measures. **Learning Via Grammatical Inference:** Learning Grammars, Problem formulation, Grammatical Inference (GI) Approaches, Procedures to Generate Constrained Grammars.		
#Exemplar/Case Studies	Structural Unification Using Attributed Graphs	
Mapping of Course Outcomes for Unit IV	CO4	
Unit V	**Neural Pattern Recognition**	**(07 Hours)**
Introduction to Neural Networks: Neurons and Neural Nets, Neural Network Structures for PR Applications, Physical Neural Networks, The Artificial Neural Network Model. **Introduction to Neural Pattern Associators and Matrix Approaches:** Neural Network Based Pattern Associators, Matrix Approaches (Linear Associative Mappings) and Examples		
#Exemplar/Case Studies	Hardware Realizations of Neural Network	
Mapping of Course Outcomes for Unit V	CO5	
Unit VI	**Feedforward Networks & Unsupervised Learning in Neural Pattern Recognition**	**(07 Hours)**
Multilayer, Feedforward Network Structure, Training the Feedforward Network: The Delta Rule, Generalized Delta Rule(GDR), Extension of the DR for Units in the Hidden layers, Pattern Associator for Character Classification, **Unsupervised Learning in NeurPR: Self organizing Networks:** Introduction, Adaptive Resonance Architectures, Self-Organizing Feature Maps(Kohonen).		
#Exemplar/Case Studies	Examples of Content Addressable Memory Applications in PR:Character Recognition, Relational Constraint Satisfaction(Coloring)	
Mapping of Course Outcomes for Unit VI	**CO6**	

Learning Resources

Text Books:

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

Reference Books:

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

e-Books:

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

MOOC Courses:

1.https://nptel.ac.in/courses/117105101
2,https://nptel.ac.in/courses/106106046

@The CO-PO mapping table

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

Savitribai Phule Pune University
Third Year of Computer Science and Design (2021 Course)
Elective I
318245C: Distributed Systems

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

Prerequisites Courses: Computer Networks (218255)

Companion Course: Laboratory Practice I (318248)

Course Objectives:

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

Course Outcomes:

On completion of the course, learners should be able to

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

Course Contents

Unit I	Introduction	07 Hours

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

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

Unit II	Communication	07 Hours

Introduction: Layered Protocols, Types of Communication, Remote Procedural Call- Basic RPC Operation, Parameter Passing, RPC-based application support, Variations on RPC, Example: DCERPC, 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, Check pointing, 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. Maartenvan Steen Andrew S.Tanenbaum, "Distributed System", Third edition,version3
2. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems Concepts and Design", Fifth edition

ReferenceBooks:

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

E-books:

- Martin Klepp mann, "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/

@The CO-PO Mapping Matrix

CO/ PO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	1	-	-	-	-	-	1
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 & Design (2021 Course)
Elective I
318245D: Data Mining and Warehousing

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses:

Companion Course: Laboratory Practice I (318248)

Course Objectives:

- To understand the fundamentals of Data Mining
- To identify the appropriateness and need of mining the data
- To learn the preprocessing, mining and post processing of the data
- To understand various methods, techniques and algorithms in data mining

Course Outcomes:

On completion of the course the student should be able to-

CO1: Apply basic, intermediate and advanced techniques to mine the data

CO2: Analyze the output generated by the process of data mining

CO3: Explore the hidden patterns in the data

CO4: Optimize the mining process by choosing best data mining technique

Course Contents

Unit I	Introduction	07 Hours

Data Mining, Data Mining Task Primitives, Data: Data, Information and Knowledge; Attribute Types: Nominal, Binary, Ordinal and Numeric attributes, Discrete versus Continuous Attributes; Introduction to Data Pre-processing, Data Cleaning: Missing values, Noisy data; Data integration: Correlation analysis; transformation: Min-max normalization, z-score normalization and decimal scaling; data reduction: Data Cube Aggregation, Attribute Subset Selection, sampling; and Data Discretization: Binning, Histogram Analysis

Unit II	Data Warehouse	07 Hours

Data Warehouse, Operational Database Systems and Data Warehouses(OLTP Vs OLAP), A Multidimensional Data Model: Data Cubes, Stars, Snowflakes, and Fact Constellations Schemas; OLAP Operations in the Multidimensional Data Model, Concept Hierarchies, Data Warehouse Architecture, The Process of Data Warehouse Design, A three-tier data warehousing architecture, Types of OLAP Servers: ROLAP versus MOLAP versus HOLAP.

Unit III	Measuring Data Similarity and Dissimilarity	07 Hours

Measuring Data Similarity and Dissimilarity, Proximity Measures for Nominal Attributes and Binary Attributes, interval scaled; Dissimilarity of Numeric Data: Minskowski Distance, Euclidean distance and Manhattan distance; Proximity Measures for Categorical, Ordinal Attributes, Ratio scaled variables; Dissimilarity for Attributes of Mixed Types, Cosine Similarity.

Unit IV	Association Rules Mining	07 Hours

Market basket Analysis, Frequent item set, Closed item set, Association Rules, a-priori Algorithm, Generating Association Rules from Frequent Item sets, Improving the Efficiency of a-priori, Mining Frequent Item sets without Candidate Generation: FP Growth Algorithm; Mining Various Kinds of Association Rules: Mining multilevel association rules, constraint-based association rule mining, Meta Rule-Guided Mining of Association Rules.

Unit V	**Classification**	**07 Hours**

Introduction to: Classification and Regression for Predictive Analysis, Decision Tree Induction, Rule-Based Classification: using IF-THEN Rules for Classification, Rule Induction Using a Sequential Covering Algorithm. Bayesian Belief Networks, Training Bayesian Belief Networks, Classification Using Frequent Patterns, Associative Classification, Lazy Learners-k-Nearest-Neighbour Classifiers, Case-Based Reasoning.

Unit VI	**Multiclass Classification**	**07 Hours**

Multiclass Classification, Semi-Supervised Classification, Reinforcement learning, Systematic Learning, Wholistic learning and multi-perspective learning. Metrics for Evaluating Classifier Performance: Accuracy, Error Rate, precision, Recall, Sensitivity, Specificity; Evaluating the Accuracy of a Classifier: Holdout Method, Random Sub sampling and Cross-Validation.

Book:

1. Han, Jiawei Kamber, Micheline Pei and Jian, “Data Mining: Concepts and Techniques”, Elsevier Publishers, ISBN:9780123814791, 9780123814807.
2. Parag Kulkarni, “Reinforcement and Systemic Machine Learning for Decision Making” by Wiley-IEEE Press, ISBN: 978-0-470-91999-6

Reference:

1. Matthew A. Russell, "Mining the Social Web: Data Mining Facebook, Twitter,LinkedIn, Google+, GitHub, and More" , Shroff Publishers, 2nd Edition, ISBN: 9780596006068
2. Maksim Tsvetovat, Alexander Kouznetsov, "Social Network Analysis for Startups: Finding connections on the social web", Shroff Publishers , ISBN: 10: 1449306462

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

Savitribai Phule Pune University
Third Year of Computer Science & Design (2021 Course)
318246: Database System Design Laboratory

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

Companion Course: Database System Design (318243)

Course Objectives:

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

Course Outcomes:

On completion of the course, learners will be able to

CO1: Design E-R Model for given requirements and convert the same into database tables

CO2: Design schema in appropriate normal form considering actual requirements

CO3: Implement SQL queries for given requirements, using different SQL concepts

CO4: Implement PL/SQL Code block for given requirements

CO5: Implement NoSQL queries using MongoDB

CO6: Design and develop application considering actual requirements and using database concepts

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal

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

Guidelines for Laboratory /Term Work Assessment

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

Guidelines for Practical Examination

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

Guidelines for Laboratory Conduction

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

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

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

Virtual Laboratory:

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

Suggested List of Laboratory Experiments/Assignments

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

Sr. No.	Group A: SQL and PL/SQL
1.	**ER Modeling and Normalization:** Decide a case study related to real time application in group of 2-3 students and formulate a problem statement for application to be developed. Propose a Conceptual Design using ER features using tools like ERD plus, ER Win etc. (Identifying entities, relationships between entities, attributes, keys, cardinalities, generalization, specialization etc.) Convert the ER diagram into relational tables and normalize Relational data model. Note: Student groups are required to continue same problem statement throughout all the assignments in order to design and develop an application as a part Mini Project. Further assignments will be useful for students to develop a backend for system. To design front end interface students should use the different concepts learnt in the other subjects also.
2.	**SQL Queries:** a. Design and Develop SQLDDL statements which demonstrate the use of SQL objects such as Table, View, Index, Sequence, Synonym, different constraints etc. b. Write at least 10 SQL queries on the suitable database application using SQL DML statements. Note: Instructor will design the queries which demonstrate the use of concepts like Insert, Select, Update, Delete with operators, functions, and set operator etc.
3.	**SQL Queries – all types of Join, Sub-Query and View:** Write at least10 SQL queries for suitable database application using SQL DML statements. Note: Instructor will design the queries which demonstrate the use of concepts like all types of Join ,Sub-Query and View
4.	**Unnamed PL/SQLcode block: Use of Control structure and Exception handling is mandatory.** Suggested Problem statement: Consider Tables: 1. Borrower(Roll_no, Name, Date of Issue, Name of Book, Status) 2. Fine(Roll_no, Date, Amt) □ Accept Roll_no and Name of Book from user. □ Check the number of days (from date of issue). □ If days are between 15 to 30 then fine amount will be Rs 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.

5.	• After submitting the book, status will change from I to R. • If condition of fine is true, then details will be stored into fine table. • Also handles the exception by named exception handler or user define exception handler. **OR** Write a PL/SQL code block to calculate the area of a circle for a value of radius varying from 5 to 9. Store the radius and the corresponding values of calculated area in an empty table named areas, consisting of two columns, radius and area. Note: Instructor will frame the problem statement for writing PL/SQL block in line with above statement**.**
6.	**Named PL/SQL Block: PL/SQL Stored Procedure and Stored Function.** Write a Stored Procedure namely proc_Grade for the categorization of student. If marks scored by students in examination is <=1500 and marks>=990 then student will be placed in distinction category if marks scored are between 989 and900 category is first class, if marks899and 825 category is Higher Second Class. Write a PL/SQLblock to use procedure created with above requirement. Stud_Marks(name, total_marks) Result(Roll,Name, Class) Note: Instructor will frame the problem statement for writing stored procedure and Function in line with above statement**.**
7.	**Cursors:(All types: Implicit, Explicit, Cursor FOR Loop, Parameterized Cursor)** Write a PL/SQL block of code using parameterized Cursor that will merge the data available in the newly created table N_Roll Call with the data available in the table O_RollCall. If the data in the first table already exist in the second table then that data should be skipped. Note: Instructor will frame the problem statement for writing PL/SQL block using all types of Cursors in line with above statement**.**
8.	**Database Trigger (All Types: Row level and Statement level triggers, Before and After Triggers).** Write a database trigger on Library table. The System should keep track of the records that are being updated or deleted. The old value of updated or deleted records should be added in Library_Audit table. Note: Instructor will Frame the problem statement for writing PL/SQLblock for all types of Triggers in line with above statement**.**
9.	**Database Connectivity:** Write a program to implement MySQL/Oracle database connectivity with any front end language to implement Database navigation operations (add, delete, edit etc.)
	Group B: NoSQL Databases
1.	**MongoDB Queries:** Design and Develop Mongo DB Queries using CRUD operations. (Use CRUD operations,SAVE method, logical operators etc.).
2.	**MongoDB – Aggregation and Indexing:** Design and Develop MongoDB Queries using aggregation and indexing with suitable example using MongoDB.
3.	**MongoDB – Map-reduces operations:** Implement Map reduces operation with suitable example using MongoDB.
4.	**Database Connectivity:** Write a program to implement Mongo DB database connectivity with any front end language to implement Database navigation operations(add, delete, edit etc.)
	Group C: Mini Project

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

Note:

- Instructor should maintain progress report of mini project through out the semester fromproject 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 and Design (2021 Course)
318247: Design and Analysis of Algorithms Laboratory

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

Companion Course: Design and Analysis of Algorithms (318244)

Course Objectives:

1. To learn the various algorithmic design paradigms.
2. To apply appropriate algorithmic strategy in problem solving.
3. To find the space and running time requirements of the algorithms.

Course Outcomes:

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

CO1: To apply algorithmic strategies for solving various problems.

CO2: To compare various algorithmic strategies.

CO3: To analyze the solution using recurrence relation

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal

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

Guidelines for Laboratory /Term Work Assessment

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

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy needs to address the average students and inclusive of an element to attract and promote the intelligent students. Use of open source software is encouraged. Based on the concepts learned. Instructors may also set one assignment or mini-project that is suitable to each branch beyond the scope of the syllabus. Operating System recommended: - 64-bit Open-source Linux or its derivative Programming tools recommended: C++, Python, Java, etc.

Suggested List of Laboratory Experiments/Assignments

Any 5 assignments and 1 mini project are mandatory.	
1	Write a program non-recursive and recursive program to calculate Fibonacci numbers and analyze their time and space complexity.
2	Write a program to implement Huffman Encoding using a greedy strategy.
3	Write a program to solve a fractional Knapsack problem using a greedy method.
4	Write a program to solve a 0-1 Knapsack problem using dynamic programming or branch and bound strategy.
5	Write a program to solve the travelling salesman problem and to print the path and the cost using Branch and Bound.
6	Design n-Queens matrix having first Queen placed. Use backtracking to place remaining Queens to generate the final n-queen ‘s matrix.
7	Write a program for analysis of quick sort by using deterministic and randomized variant
8	**Mini Project** - Write a program to implement matrix multiplication. Also implement multithreaded matrix multiplication with either one thread per row or one thread per cell. Analyze and compare their performance.
9	**Mini Project** - Implement merge sort and multithreaded merge sort. Compare time required by both the algorithms. Also analyze the performance of each algorithm for the best case and the worst case.
10	**Mini Project** - Implement the Naive string-matching algorithm and Rabin-Karp algorithm for string matching. Observe difference in working of both the algorithms for the same input.
11	**Mini Project** - Different exact and approximation algorithms for Travelling-Sales-Person Problem

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Science & Design (2021 Course)
318248: Laboratory Practice-I

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

Companion Course: Internet of Things(318245A), Pattern Recognition(318245B), Distributed Systems(318245C), Data Mining and warehousing (318245D)

Course Objectives:

1. To learn various techniques, tools, applications in IoT.
2. To understand fundamentals of pattern recognition.
3. To learn various techniques, tools, applications in Distributed Systems
4. To learn the pre-processing, mining and post processing of the data

Course Outcomes:

On completion of the course, learners will be able to

CO1: Develop smart applications using IoT
CO2: Implement different approaches of syntactic pattern recognition.
CO3: Apply the principles of state-of-the-Art Distributed Systems in real time applications
CO4: Analyze the output generated by the process of data mining

Guidelines for Instructor's Manual

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

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

Guidelines for Laboratory /Term Work Assessment

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

Guidelines for Oral Examination

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 mindsof the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.

Suggested List of Laboratory Experiments/Assignments.

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

Group A: Internet of Things	
1	Study of Raspberry-Pi, Beagle board, Arduino.
2	Understanding the connectivity of Raspberry-Pi / Adriano with IR sensor. Write an application to detect obstacle and notify user using LEDs.
3.	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.
4	Understanding and connectivity of Raspberry-Pi /Beagle board with camera. Write an application to capture and store the image.
5	Create a small dashboard application to be deployed on cloud. Different publisher devices can publish their information and interested application can subscribe.
Group B: Pattern Recognition	
1.	Use Bayesian Decision theory of statistical pattern recognition to classify the object
2.	Implement Cocke–Younger–Kasami (CYK) Parsing Algorithm using Syntactic Pattern Recognition
3.	Generate a Pattern from String using syntactical Pattern Approach
4.	Apply suitable pattern recognition technique to perform Character Recognition
5.	Develop a system for Handwritten Digit Recognition using Neural Network
Group C: Distributed Systems	
1	Implementation of Inter-process communication using socket programming: implementing multithreaded echo server.
2	Implementation of RPC Mechanism.
3	Simulation of election algorithms using Ring.
4	Simulation of election algorithms using Bully.
5	Implementation of Clock Synchronization: a) NTP b) Lamports clock.
Group D: Data Mining and warehousing	
1	For an organization of your choice, choose a set of business processes. Design star / snow flake schemas for analyzing these processes. Create a fact constellation schema by combining them. Extract data from different data sources, apply suitable transformations and load into destination tables using an ETL tool. For Example: Business Origination: Sales, Order, Marketing Process.
2	Consider a suitable dataset. For clustering of data instances in different groups, apply different clustering techniques (minimum 2). Visualize the clusters using suitable tool.
3	Apply a-priori algorithm to find frequently occurring items from given data and generate strong association rules using support and confidence thresholds. For Example: Market Basket Analysis
4	Consider a suitable text dataset. Remove stop words, apply stemming and feature selection techniques to represent documents as vectors. Classify documents and evaluate precision, recall.

Learning Resources

References:

1. R.O.Duda, P.E.Hart and D.G.Stork, “Pattern Classification”, John wiley ISBN-978-0-471- 05669-0.

2.Matthew A. Russell, "Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More”, Shroff Publishers, 2nd Edition, ISBN: 9780596006068

3.. The Internet of Things Key applications and protocols Olivier Hersent Willy Publications 2nd Edition 978-1-119-99435-0

4. Andrew R.Webb, Keith D.Copsey,”Statistical Pattern Recognition”,3rd edition Wiely , ISBN:978-0-470-68227-2

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

Savitribai Phule Pune University
Third Year of Computer Science and Design (2021 Course)
318249: Seminar and Technical Communication

Teaching Scheme	Credit: 01	Examination Scheme and Marks
Tutorial: 01 Hour/Week		Term Work: 25 Marks

Course Objectives:

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

Course Outcomes:

On completion of the course, learners will be able to

CO1: Analysis specialized topic of interest from core area
CO2: Enhance Technical writing skills
CO3: Targeting specific problem and identify working solution to resolve it.
CO4: Developing professional communication skill

Guidelines

- Each student will select a topic in the area of Computer Engineering and Technology preferably keeping track with recent technological trends and development beyond scope of syllabus avoiding repetition in consecutive years.
- The topic must be selected in consultation with the Institute guide.
- Each student will make a seminar presentation using audio/visual aids for a duration of 20-25 minutes and submit the seminar report.
- 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 Computer Science & Design (2021 Course)

318250: Environmental Studies

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

Prerequisite Courses, if any: Multidisciplinary nature of environmental studies; components of environment – atmosphere, hydrosphere, lithosphere and biosphere.

Companion Course, if any:

Preamble:
An environmental study is a multidisciplinary academic field which systematically studies human interaction with the environment. Environmental studies connect principles from the physical sciences, commerce/economics, the humanities, and social sciences to address complex contemporaryenvironmental issues. Imparting basic knowledge about the environment and its allied problems.
Developing an attitude of concern for the environment.

Course Objectives:

- To gain an understanding of the Environment where we live
- Understanding the importance of water
- To educate about Air and Noise pollution
- To explain the concepts of E- waste and Green Computing

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

CO1: Aware the importance of environment
CO2: Understand the water pollution
CO3: Know the Air and noise pollution
CO4: Understand the E-waste and green computing

Course Contents

Unit I	**Introduction to Environmental Pollution**	**(03 Hours)**

Environmental pollution: Environment and its importance, Definition, Types. Effect of environmental pollution on Plants, Non-living things.

Unit II	**Water Pollution**	**(03 Hours)**

Water Pollution: Definition, Sources of water Pollution, Types of wastewater-Domestic and industrial wastewater

Unit III	**Air Pollution and Noise Pollution**	**(03 Hours)**

Air pollution: Definition, Sources/causes of air pollution. Atmospheric layers, Effects on human. **Noise Pollution:** Definition of Noise Pollution, Types of Noise Pollution

Unit IV	**E-waste Management and Green computing**	**(03 Hours)**

E-waste management: Definition of E-waste, Sources of E-waste, Types of E-waste , **Green computing:** Definition, Objectives of Green Computing, Necessity, Environmental benefits

Tutorial Conduction and Term work Guidelines (Set of Suggested Activities)

The students are expected to submit

1) Report/Presentation on the effect of Environmental Pollution on any world-famous Structure/monument.
2) Report/Presentation on importance of different sources of water available nearby them.
3) Report/Presentation based on the data collected from the local authorities on air pollution and noisepollution.
4) Report/Presentation on the E-Waste generated in the campus.

Learning Resources

Text Books:

1.“The text book of Environmental studies”, Dr. P. D. Raut, Shivaji University, 2013.
2.“A Text Book of Environmental Studies”, Dr. D. K. Asthana, S. Chand.

Reference Books:

1. "Air Pollution", M. N. Rao, McGrawHill, Publication.
2. "E-waste Management and Procurement of Environment", Dr. Suresh Kumar, Authorspress,2021.
3. "Green Computing Approach towards sustainable development", M. Afshar Alam, Dreamtech Press. 2020.

Savitribai Phule Pune University
Third Year Computer Science and Design (2021 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):

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

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

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

Audit Course 5 Options

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

Savitribai Phule Pune University
Third Year Computer science and Design (2021 Course)
Audit Course 5
310250(A): Cyber Security

Prerequisites: Computer Network and Security

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, Cyber stalking, Cyber cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing.
3. **Tools and Methods Used in Cybercrime :** Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks **(Expected to cover the introduction to all these terms)**
4. **Cybercrime: Illustrations, Examples and Mini-Cases :**Introduction, Real-Life Examples, Mini-Cases, Illustrations of Financial Frauds in Cyber Domain, Digital Signature-Related Crime Scenarios, Digital Forensics Case Illustrations, Online Scams.

References 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 6thEd, ISBN 978-0-13-335469-0

Reference Books :

1. Berouz Forouzan, "Cryptography and Network Security", TMH, 2 edition, ISBN -978-0707-0208-0. 5.
2. Mark Merkow, "Information Security-Principles and Practices", Pearson Ed., ISBN- 9781-317-1288-7
3. CK Shyamala et el., "Cryptography and Security", Wiley India Pvt. Ltd, ISBN-978-8265-2285-9 317-1288-7

@The CO-PO Mapping Matrix

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

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

Savitribai Phule Pune University
Third Year Computer Science and Design (2021 Course)
Audit Course 5
310250(B): Professional Ethics and Etiquettes

Prerequisites: Business Communication Skill

Course Objectives:

- To learn importance of ethics and the rules of good behaviour 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, lSBN- 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

Savitribai Phule Pune University
Third Year Computer Science and Design (2021 Course)
Audit Course 5
310250(C): Learn New Skills- Full Stack Developer

Prerequisites: Programming Skills

Course Objectives:

- To understand the fundamental concepts in designing web based applications and applying frontend and backend technologies
- To understand the fundamental concepts in applying database techniques in application
- To 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.

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

@The CO-PO Mapping Matrix

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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

Savitribai Phule Pune University
Third Year Computer Science and Design(2021 Course)
Audit Course 5
310250(D): Engineering Economics

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

Savitribai Phule Pune University
Third Year Computer Science and Design (2021 Course)
Audit Course 5
310250(E): Foreign Language (Japanese)-Module 3

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

Course Objectives:

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

Course Outcomes:

On completion of the course, learners will be able to

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

CO2: Understand and use Japanese script to read and write

CO3: Apply knowledge for next advance level reading, writing and listening skills

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

Course Contents

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

Reference Books :

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

@The CO-PO Mapping Matrix

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

Semester VI

Savitribai Phule Pune University
Third Year of Computer Science and Design (2021 Course)
318251: Artificial Intelligence

Teaching Scheme:	**Credit: 03**	**Examination Scheme:**
Theory: 04 Hours/Week		**In-Sem (TH) : 30 Marks**
		End-Sem (TH): 70 Marks

Prerequisites Courses: Programming and Problem solving (110005), Data Structure and Algorithms (218242)

Companion Course: Laboratory Practice II (318257)

Course Objectives:

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

Course Outcomes:

After completion of the course, students should be able to

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

Course Contents

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

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

#Exemplar/Case Studies	Kroger: How This U.S. Retail Giant Is Using AI And Robots To Prepare For The 4th Industrial Revolution
***Mapping of Course Outcomes for Unit I**	CO1, CO4

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

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

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

Unit III	Adversarial Search and Games	07 Hours
Game Theory, Optimal Decisions in Games, Heuristic Alpha–Beta Tree Search, Monte Carlo Tree Search, Stochastic Games, Partially Observable Games, Limitations of Game Search Algorithms, Constraint Satisfaction Problems (CSP), Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs.		
#Exemplar/Case Studies	Machine Learning At Google: The Amazing Use Case Of Becoming A Fully Sustainable Business	
***Mapping of Course Outcomes for Unit III**	CO3, CO4	
Unit IV	**Knowledge**	**07 Hours**
Logical Agents, Knowledge-Based Agents, The Wumpus World, Logic, Propositional Logic: A Very Simple Logic, Propositional Theorem Proving, Effective Propositional Model Checking, Agents Based on Propositional Logic, First-Order Logic, Representation Revisited, Syntax and Semantics of First-Order Logic, Using First-Order Logic, Knowledge Engineering in First-Order Logic.		
#Exemplar/Case Studies	BBC To Launch AI - Enabled Interactive Radio Show For Amazon Echo And Google Home Chat bots	
***Mapping of Course Outcomes for Unit IV**	CO3, CO4	
Unit V	**Reasoning**	**07 Hours**
Inference in First-Order Logic, Propositional vs. First-Order Inference, Unification and First-Order Inference, Forward Chaining, Backward Chaining, Resolution, Knowledge Representation, Ontological Engineering, Categories and Objects, Events, Mental Objects and Modal Logic, Reasoning Systems for Categories, Reasoning with Default Information		
#Exemplar/Case Studies	The Amazing Ways How Wikipedia Uses Artificial Intelligence	
***Mapping of Course Outcomes for Unit V**	CO4, CO5	
Unit VI	**Planning**	**07 Hours**
Automated Planning, Classical Planning, Algorithms for Classical Planning, Heuristics for Planning, Hierarchical Planning, Planning and Acting in Nondeterministic Domains, Time, Schedules, and Resources, Analysis of Planning Approaches, Limits of AI, Ethics of AI, Future of AI, AI Components, AI Architectures.		
#Exemplar/Case Studies	The Amazing Ways Samsung Is Using Big Data, Artificial Intelligence And Robots To Drive Performance	
***Mapping of Course Outcomes for Unit VI**	CO4, CO6	

Learning Resources

Text Books:

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

Reference Books:

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

e-Books :

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

MOOCs Courses link:

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

@ The CO-PO Mapping Matrix

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

Savitribai Phule Pune University

Third Year of Computer Science and Design (2021 Course)

318252: Web Technology and Application Design

Teaching Scheme:	**Credit: 03**	**Examination Scheme:**
Theory :04 Hours/Week		**In-Sem (TH) : 30 Marks**
		End-Sem (TH): 70 Marks

Prerequisites Courses: Database System Design (318243), Computer Networks (218255)

Companion Course: Web Technology and Application Design Laboratory(318255)

Course Objectives:

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

Course Outcomes:

On completion of the course, learners should be able to

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

Course Contents

Unit I	**Web Essentials and Mark-up language- HTML**	**07 Hours**

The Internet, basic internet protocols, the World Wide Web, HTTP Request message, HTTP response message, web clients, web servers.**HTML**: Introduction, history and versions.**HTML elements**: headings, paragraphs, line break, colors and fonts, links, frames, lists, tables, images and forms, Difference between HTML and HTML5. **CSS**: Introduction to Style Sheet, CSS features, CSS core syntax, Style sheets and HTML, Style rule cascading and inheritance, text properties. Bootstrap.

#Exemplar/Case Studies	Create a style sheet suitable for blogging application using HTML and using style sheet
***Mapping of Course Outcomes for Unit I**	CO1

Unit II	**Client Side Technologies: JavaScript and DOM**	**07 Hours**

JavaScript: Introduction to JavaScript, JavaScript in perspective, basic syntax, variables and data types, statements, operators, literals, functions, objects, arrays, built in objects, JavaScript debuggers. **DOM**: Introduction to Document Object Model, DOM history and levels, intrinsic event handling, modifying element style, the document tree, DOM event handling, jQuery, Overview of Angular JS.

#Exemplar/Case Studies	Enhancement in created blogging application using JavaScript (Add Entry feature)
***Mapping of Course Outcomes for Unit II**	CO2

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

Reference Books :

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

e-Books :

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

MOOCs Courses link:

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

@ The CO-PO Mapping Matrix

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

Savitribai Phule Pune University

Third Year of Computer Science and Design (2021 Course)

318253: UI/UX Design

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisites Courses: Design Thinking (218256)

Companion Course: UI/UX design Laboratory (318256)

Course Objectives:

- To learn the factors that determine how people use technology
- To study the usable software-enabled user-interfaces
- To achieve efficient, effective, and safe interaction
- To Explore various models and factors that affect response time
- To explore the challenges associated with information visualization and its societal and individual impacts.
- To learn Usability evaluation methods:

Course Outcomes:

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

CO1 : Understand the principles of User Interface

CO2: Describe user experience fundamentals

CO3: Explore strategies for managing design projects.

CO4: Recognize the quality of service and data visualization

CO5: Explore the challenges associated with information visualization

CO6 : Test the usability of a design through usability evaluations

Course Contents

Unit I	Introduction and Overview of UI	08 Hours

The Human –I/P, O/P channels, Human Memory, thinking, emotion, individual difference (diversity), human psychology.

Introduction to User Interface Design (UI) -The Relationship Between UI and UX , Roles in UI/UX, A Brief historical Overview of Interface Design, Interface Conventions, Approaches to Screen Based UI, Template vs Content, Formal Elements of Interface Design, Active Elements of Interface Design, Composing the Elements of Interface Design, UI Design Process, Visual Communication design component in Interface Design , Application of UI design

Introduction to Design Technologies and Tools Sketch ,Wireframe ,Invision, Axure, Figma, Flutter, Mockups

#Exemplar/Case Studies	Redesigning a Mobile E-commerce App
*Mapping of Course Outcomes for Unit I	CO1

Unit II	User Experience	08 Hours

UX Basics- Foundation of UX design, Good and poor design, Understanding Your Users, Designing the Experience Elements of user Experience, Visual Design Principles, Functional Layout, Interaction design, Introduction to the Interface, Navigation Design, User Testing, Developing and Releasing Your Design User experience and user interaction-Usability of interactive systems, goals and measures, Universal Usability, Characteristics of graphical and web user interfaces, guidelines, principles andtheories of good design, User Experience- Concept of UX, Trends in UX, 6 Stages used to UX design , Applications of UX design

#Exemplar/Case Studies	Redesigning a Health and Fitness Mobile App
***Mapping of Course Outcomes for Unit II**	CO1,CO2

Unit III	**Design Process**	**07 Hours**

Managing design processes, organizational design to support usability, pillars of design, development methodologies, Human considerations in Design, Usability- principles to support usability, assessment in the design process, Usability problems, practical measures of usability, objective measures of usability, golden rules of interface design, Evaluating Interface Design – Introduction, Expert reviews, Usability testing, Acceptance tests, Legal issues

#Exemplar/Case Studies	Redesign of a mobile banking application.
***Mapping of Course Outcomes for Unit III**	CO3

Unit IV	**Interaction Styles**	**07 Hours**

Direct manipulation and virtual environment, Develop system menus and navigation schemes- Structure of menus, Function of menus, content of menus, phrasing the menu,navigating menus, kinds of graphical menus, form fill-in and dialog boxes, command-organization , functionality, strategies and structure, naming and abbreviations, interaction devices, collaboration and social media participation

#Exemplar/Case Studies	Smart Home Control Application -The Smart Home Control App exemplifies a UI/UX design interaction style that focuses on simplicity, intuitiveness, and convenience
***Mapping of Course Outcomes for Unit IV**	CO4

Unit V	**Implementation support and Screen Based Controls**	**07 Hours**

Implementation support: Support, training and learning, requirement of user support, element of windowing systems,Individual window design, multiple window design, command organization strategies command menus, natural languages in computer **Screen Based Controls:** Selection control-Radio buttons, check boxes, list boxes, Read-only controls- text boxes, Operablecontrols - buttons, slider, tab, scroll bar, clear text and messages, text for web pages, Graphics, icons and images, Presentation controls-Static text fields, Group boxes, column headings, tool tips,progress indicators

#Exemplar/Case Studies	Mobile Banking Application -Application that allows users to manage their finances and perform various banking tasks such as checking account balances, transferring funds, and paying bills.
***Mapping of Course Outcomes for Unit V**	CO5

Unit VI	**Usability Evaluation and Design Issues**	**07 Hours**

Quality of service- Models of response time impacts, user productivity, variability in response time, Balancing function and fashion- Error messages, display design, web page design, window design, color, Information visualization – data type by task taxonomy, challenges for information visualization, societal and individual impact of user interface.

Usability Evaluation Methods : Usability Testing ,Heuristic evaluations , Cognitive walkthrough, Surveys and Questionnaires Eye Tracking, A/B Testing, Remote Usability Testing, Think-Aloud Protocol, Comparative Usability Evaluation.

Industry Trends and Case Studies, Professional practices and career opportunities in UI/UX design

#Exemplar/Case Studies	Select a real world app/existing product/prototype evaluate it for usability. Ensure that it has sufficient complexity to evaluate various aspects of usability
***Mapping of Course Outcomes for Unit VI**	CO6

Learning Resources

Text Books:

1. Creative Tim ,"Fundamentals of Creating a Great UI/UX", First Edition
2. Jon Yablonski, "Laws of UX: Using Psychology to Design Better Products & Services" , O'Reilly Media, Inc.", 21-Apr-2020 , First Edition
3. Jenifer Tidwell, Charles Brewer, Aynne Valencia "Designing Interfaces: Patterns for Effective Interaction Design"**,** O'Reilly Media, Inc.", First Edition

Reference Books :

1. Shneiderman, Plaisant, Cohen, Jacobs, "Designing the User Interface-Strategies for Effective Human Computer Interaction", 5th Edition ,PEARSON Publication, ISBN 97881317-3255-7
2. Wilbert O. Galitz "The Essential Guide to User Interface Design", 2nd Edition, WILEY Publication, 9780471271390, 047127139X.
3. Alan Dix, Janet Finlay, Gregory D. Abowd, Russell Beale, "Human–Computer Interaction, 3rdEdition, PEARSON education , 9788131717035, 8131717038
4. Alan Coopen, "The essentials of interaction", Wiley , ISBN:9781568843223, 1568843224

e-Books :

1. "The Guide to Wireframing" by UXPin: https://www.uxpin.com/studio/ebooks/guide-to-wireframing/ - This eBook provides an in-depth guide to wireframing, covering the basics, best practices, and tips for creating effective wireframes.
2. "UX Design for Startups" by Marcin Treder: https://uxpin.com/studio/ebooks/ux-design-for-startups/ - This eBook focuses on UX design principles and strategies specifically tailored for startups, covering topics like user research, prototyping, and user testing.

MOOC Courses links :

- https://onlinecourses.nptel.ac.in/noc21_ar05/preview

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University

Third Year of Computer Science and Design (2021 Course)

Elective II

318254 (A): Multimedia Technique

Teaching Scheme: Theory: 04 Hours/Week	Credit: 03	Examination Scheme: In-Sem (TH) : 30 Marks End-Sem (TH): 70 Marks

Prerequisite Courses: Computer Graphics (210244)

Companion Course: Laboratory Practice II (318257)

Course Objectives:

- To understand input and output devices, device drivers, control signals and protocols, DSPs
- To study and use standards (e.g., audio, graphics, video)
- To implement applications, media editors, authoring systems, and authoring by studyingstreams/structures, capture/represent/transform, spaces/domains, compression/coding
- To design and develop content-based analysis, indexing, and retrieval of audio,images, animation, and video
- To demonstrate presentation, rendering, synchronization, multi-modal integration/interfaces
- To Understand IoT architecture's and Multimedia Internet of things

Course Outcomes:

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

CO1: Describe the media and supporting devices commonly associated with multimedia information and systems.

CO2: Demonstrate the use of content-based information analysis in a multimedia information system.

CO3: Critique multimedia presentations in terms of their appropriate use of audio, video, graphics, color ,and other information presentation concepts.

CO4: Implement a multimedia application using an authoring system.

CO5: Understanding of technologies for tracking, navigation and gestural control.

CO6: Implement Multimedia Internet of Things Architectures

Course Contents

Unit I	Introduction to multimedia	07 Hours

What is Multimedia and their Components, History of Multimedia; Hypermedia, WWW, and Internet; Multimedia Tools: Static (text, graphics, and still images), Active (sound, animation, and video, etc.); Multimedia Sharing and Distribution; Multimedia Authoring Tools: Adobe Premiere, Adobe Director, Adobe Flash.

#Exemplar/Case Studies	To study and install open-source multimedia Tools
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Graphics and Data Representation Techniques	07 Hours

What are Graphics data types, 1-bit Images, 8 –bit grey level ,16-bit grey level images, Image datatype,Image data type:8 bit & 24-bit color images, Higher bit depth images, Color Lookup tables. File Formats: GIF, JPEG, PNG, TIFF, PSD, APS, AI, INDD, RAW, Windows BMP, Windows WMF, Netpbm format, EXIF, PTM, Text file format: RTF, TGA Applications/Use of text in Multimedia

#Exemplar/Case Studies	To study conversion of image file formats from one to Other.

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

Unit III	**Multimedia Representations Techniques**	**07 Hours**

Principal concepts for the analog video: CRT, NTSC Video (National Television System Committee), PAL Video (Phase Alternating Line), SECAM Video (System Electronic Couleur Avec Memoire), DigitalVideo: Chroma Subsampling, High-Definition TV, Ultra High Definition TV (UHDTV), Component Video: High-Definition Multimedia Interface (HDMI),3D Video and TV: various cues, Basics of Digital Audio: What is Sound?, Nyquist Theorem, SNR, SQNR, Audio Filtering, Synthetic Sounds, MIDI Overview: Hardware, Structure, Conversion to WAV, Coding of Audio: PCM, DPCM, DM (Delta Modulation)

#Exemplar/Case Studies	Install and use Handbrake (link is https://handbrake.fr) software to understand the concept of interlaced, deinterlace, noise filters, bitrate, and frame rate for any sample 30 min video, and note down the observations from the output video.
***Mapping of Course Outcomes for Unit III**	CO3

Unit IV	**Compression Algorithms**	**07 Hours**

Introduction to multimedia – Graphics, Image and Video representations – Fundamental concepts of video, digital audio – Storage requirements of multimedia applications – Need for compression – Types ofcompression algorithms- lossless compression algorithms RLC, VLC, DBC, AC, lossless image compression, differential coding of Images, lossy compression algorithms-Rate distortion theory, Quantization, Transform coding, wavelet based coding, embedded Zerotress of wavelet coefficients. Image compression standard -JPEG standard, JPEG 2000 standard, LS standard, Bilevel image compression standard. Introduction to video compression - video compression based on motion compensation, Search for motion vectors, MPEG Video coding I , MPEG 1,2,4,7 onwards. Basic Audio Compression Techniques -ADPCM in speech coding, Vocoders, MPEG audio compression

#Exemplar/Case Studies	Implementation of compression algorithms
***Mapping of Course Outcomes for Unit IV**	CO3 and CO4

Unit V	**Augmented Reality(AR), Virtual Reality (VR) and Mixed Reality (MR)**	**07 Hours**

Basics of Virtual Reality, difference between Virtual Reality and Augmented Reality, Requirement of Augmented Reality, Components and Performance issues in AR, Design and Technological foundationsfor Immersive Experiences. Input devices – controllers, motion trackers and motion capture technologies for tracking, navigation and gestural control. Output devices – Head Mounted VR Displays, Augmented and Mixed reality glasses. 3D interactive and procedural graphics. Immersive surround sound. Haptic and vibrotactile devices. Best practices in VR, AR and MR Future applications of Immersive Technologies. VRML Programming Modeling objects and virtual environments Domain Dependent applications: Medical, Visualization, Entertainment, etc.

#Exemplar/Case Studies	Navigation Assistance System
***Mapping of Course Outcomes for Unit V**	CO5

Unit VI	Multimedia Internet of Things	07 Hours
IoT and Multimedia IoT Architecture: IoT Architecture; M-IoT Architectures: Multi-Agent Based, AI- Based Software-Defined, Big Data Layered; Applications of M-IoT: Road Management System, Multimedia IoT in Industrial Applications, Health Monitoring		
#Exemplar/Case Studies	Traffic Monitoring System	
***Mapping of Course Outcomes for Unit VI**	CO6	

Learning Resources

Text Books:

1. Tay Vaughan, "Multimedia making it work", Tata McGraw-Hill, 2011, ISBN: 978-0-07-174850-6 MHID: 0-07-174850-4, eBook print version of this title: ISBN: 978-0-07-174846-9, MHID: 0-07- 174846-6
2. Ze-Nian Li, Mark S. Drew and Jiang chuan Liu, "Fundamentals of Multimedia", Second Edition,Springer, 2011, ISSN 1868-0941 ISSN 1868-095X (electronic), ISBN 978-3-319-05289-2 ISBN 978-3-319-05290-8 (eBook), DOI 10.1007/978-3-319-05290-8, Pearson Education, 2009.

Reference Books:

1. Ali Nauman et al. "Multimedia Internet of Things: A Comprehensive Survey", Special Section on Mobile Multimedia: Methodology and Applications, IEEE Access, Volume 8, 2020
2. Kelly S. Hale (Editor), Kay M. Stanney (Editor). 2014. Handbook of Virtual Environments: Design,Implementation, and Applications, Second Edition (Human Factors and Ergonomics) ISBN-13: 978- 1466511842. Amazon

e-Books :

- https://users.dimi.uniud.it/~antonio.dangelo/MMS/materials/Fundamentals_of_Multimedia.pdf
- https://mu.ac.in/wp-content/uploads/2021/04/Multimedia.pdf
- https://www.baschools.org/pages/uploaded_files/chap13.pdf

MOOCs Courses link:

https://nptel.ac.in/courses/117105083

@ The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Science and Design (2021 Course)
Elective II
318254 (B): Augmented and Virtual Reality

Teaching Scheme:	**Credit: 03**	**Examination Scheme:**
Theory: 04 Hours/Week		**In-Sem (TH) : 30 Marks**
		End-Sem (TH): 70 Marks

Prerequisites Courses: Computer Graphics (210244)

Companion Course: Laboratory Practice II (318257)

Course Objectives:

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

Course Outcomes:

On completion of the course, learners should be able to

CO1: Understand the basics of Augmented and Virtual reality systems and list their applications
CO2: Describe interface to the Virtual World with the help of input and output devices
CO3: Explain representation and rendering system in the context of Virtual Reality
CO4: Analyze manipulation, navigation and interaction of elements in the virtual world
CO5: Summarize the basic concepts and hardware of Augmented Reality system
CO6: Create Mobile Augmented Reality using Augmented Reality techniques and software

Course Contents

Unit I	**Introduction**	**06 Hours**

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

#Exemplar/Case Studies	Timeline of evolution of AR from VR and Case study of a single application using both VR and AR technologies
***Mapping of Course Outcomes for Unit I**	CO1

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

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

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

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

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

#Exemplar/Case Studies	Study the use of Virtual Reality at NASA

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

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

Learning Resources

Text Books:

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

Reference Books:

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

e-Books :

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

MOOC Courses link:

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

@ The CO-PO Mapping Matrix

CO/ PO	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	1	2	1	-	-	-	-	-	-	-	-
CO2	1	2	2	-	-	-	-	-	-	-	-	-
CO3	1	2	2	1	2	-	-	-	-	-	-	1
CO4	1	2	2	-	2	-	-	-	-	-	-	1
CO5	1	1	2	2	1	-	-	-	-	-	-	2
CO6	1	2	2	2	3	-	-	-	-	-	-	2

Savitribai Phule Pune University
Third Year of Computer Science and Design (2021 Course)
Elective II
318254 (C): Cloud Computing

Teaching Scheme:	**Credit: 03**	**Examination Scheme:**
Theory: 04 Hours/Week		**In-Seme (TH) : 30 Marks**
		End-Sem (TH): 70 Marks

Prerequisites Courses: Computer Networks (218255)

Companion Course: Laboratory Practice II (318257)

Course Objectives:

- To study fundamental concepts of cloud computing
- To learn various data storage methods on cloud
- To understand the implementation of Virtualization in Cloud Computing
- To learn the application and security on cloud computing
- To study risk management in cloud computing
- To understand the advanced technologies in cloud computing

Course Outcomes:

On completion of the course, learners should be able to

CO1: Understand the different Cloud Computing environment
CO2: Use appropriate data storage technique on Cloud, based on Cloud application
CO3: Analyze virtualization technology and install virtualization software
CO4: Develop and deploy applications on Cloud
CO5: Apply security in cloud applications
CO6: Use advance techniques in Cloud Computing

Course Contents

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

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

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

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

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

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

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

Unit III	**Virtualization in Cloud Computing**	**07 Hours**

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

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

Unit IV	**Cloud Platforms and Cloud Applications**	**07 Hours**

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

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

Unit V	**Security in Cloud Computing**	**07 Hours**

Risks in Cloud Computing: Risk Management, Enterprise-Wide Risk Management, Types of Risks in Cloud Computing. **Data Security in Cloud**: Security Issues, Challenges, advantages, Disadvantages, Cloud Digital persona and Data security, Content Level Security. **Cloud Security Services**: Confidentiality, Integrity and Availability, Security Authorization Challenges in theCloud, 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 Tends in cloud Computing, Mobile Cloud, **Automatic Cloud Computing**: Comet Cloud. **Multimedia Cloud**: IPTV, Energy Aware Cloud Computing, Jungle Computing, Distributed Cloud Computing Vs Edge Computing, Containers, Docker, and Kubernetes, Introduction to DevOps. **IOT and Cloud Convergence**: The Cloud and IoT in your Home, The IOT and cloud in your Automobile, PERSONAL: IoT in Healthcare.

#Exemplar/Case Studies	Case studies on Dev Ops: DocuSign, Forter, Gengo.
***Mapping of Course Outcomes for Unit VI**	CO6

Learning Resources

Text Books :

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

Reference Books :

1. James Bond ,"The Enterprise Cloud", O'Reilly Media, Inc. ISBN: 9781491907627
2. Dr. Kris Jamsa, "Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more", Wiley Publications, ISBN: 978-0-470-97389-9
3. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach", 2010, The McGraw-Hill.
4. Gautam Shrof, "ENTERPRISE CLOUD COMPUTING Technology Architecture, Applications", Cambridge University Press, ISBN: 9780511778476
5. Tim Mather, Subra K, Shahid L.,"Cloud Security and Privacy", Oreilly, ISBN-13 978-81-8404-815-5
6. Dr. Kumar Saurabh, "Cloud Computing, 4ed: Architecting Next-Gen Transformation Paradigms", Wiley publication, ISBN: 9788126570966
7. Rishabh Sharma, "Cloud Computing: Fundamentals, Industry Approach and Trends", Wiley publication, ISBN:

e-Books :

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

MOOCs Courses link:

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

Savitribai Phule Pune University

Third Year of Computer Science and Design (2021 Course)

Elective II

318254(D): Business Intelligence and Data Analytics

Teaching Scheme:	**Credit: 03**	**Examination Scheme:**
Theory: 04 Hours/Week		**In-Sem (TH) : 30 Marks**
		End-Sem (TH): 70 Marks

Prerequisites Courses: Database System design (318243) , Discrete mathematics (210241)

Companion Course: Laboratory Practice II (318257)

Course Objectives:

- To introduce the concepts and components of Business Intelligence (BI)
- To evaluate the technologies that make up BI (data warehousing, OLAP)
- To identify the technological architecture of BI systems·
- To explain different data preprocessing techniques
- To identify machine learning model as per business need
- To understand the BI applications in marketing, logistics, finance and telecommunication sector

Course Outcomes:

On completion of this course, the students will be able to

CO1: Differentiate the concepts of Decision Support System & Business Intelligence

CO2: Use Data Warehouse & Business Architecture to design a BI system.

CO3: Build graphical reports

CO4: Apply different data preprocessing techniques on dataset

CO5: Implement machine learning algorithms as per business needs

CO6: Identify role of BI in marketing, logistics, and finance and telecommunication sector

Course Contents

Unit I	**Introduction to Decision Support Systems and Business Intelligence**	**07 Hours**

Decision support systems: Definition of system, representation of the decision-making process, evolution of information systems, Decision Support System, Development of a decision support system, the four stages of Simon's decision-making process, and common strategies and approaches of decision makers.

Business Intelligence: BI, its components & architecture, previewing the future of BI, crafting a better experience for all business users, End user assumptions, setting up data for BI, data, information and knowledge, The role of mathematical models, Business intelligence architectures, Ethics and business intelligence

#Exemplar/Case Studies	Decision support system in business intelligence: https://www.riverlogic.com/blog/five-decision-support-system-examples
***Mapping of Course Outcomes for Unit I**	CO1

Unit II	**The architecture of DW and BI**	**07 Hours**

BI and DW architectures and its types - Relation between BI and DW - OLAP (Online analytical processing) definitions - Different OLAP Architectures-Data Models-Tools in Business Intelligence-Role of DSS, EIS, MIS and digital Dash boards – Need for Business Intelligence

Difference between OLAP and OLTP - Dimensional analysis - What are cubes? Drill-down and roll-up - slice and dice or rotation - OLAP models - ROLAP versus MOLAP - defining schemas: Stars, snowflakes and fact constellations

#Exemplar/Case Studies	A case study on Retail Industry : https://www.diva-portal.org/smash/get/diva2:831050/FULLTEXT01.pdf
***Mapping of Course Outcomes for Unit II**	CO2

Unit III	**Reporting Authoring**	**08 Hours**

Building reports with relational vs Multidimensional data models; Types of Reports – List, crosstabs, Statistics, Chart, map, financial etc; Data Grouping & Sorting, Filtering Reports, Adding Calculations to Reports, Conditional formatting, Adding Summary Lines to Reports. Drill up, drill- down, drill-through capabilities. Run or schedule report, different output forms – PDF, excel, csv, xml etc.

#Exemplar/Case Studies	Power BI Case Study – How the tool reduced hassles of Heathrow & Edsby:
***Mapping of Course Outcomes for Unit III**	CO3

Unit IV	**Data preparation**	**07 Hours**

Data validation: Incomplete data ,Data affected by noise .Data transformation: Standardization , Feature extraction. Data reduction : Sampling, Feature selection, Principal component analysis, Data discretization .Data exploration : 1.Univarate analysis :Graphical analysis of categorical attributes ,Graphical analysis of numerical attributes , Measures of central tendency for numerical attributes , Measures of dispersion for numerical attributes, Identification of outliers for numerical attributes 2.Bivariate analysis: Graphical analysis , Measures of correlation for numerical attributes , Contingency tables for categorical attributes, 3.Multivariate analysis: Graphical analysis , Measures of correlation for numerical attributes

#Exemplar/Case Studies	Case study on Data preparation phase of BI system https://blog.panoply.io/load-and-transform-how-to-prepare-your-data-for-business-intelligence
***Mapping of Course Outcomes for Unit IV**	CO4

Unit V	**Impact of Machine learning in Business Intelligence Process**	**07 Hours**

Classification: Classification problems, Evaluation of classification models, Bayesian methods, Logistic regression. Clustering: Clustering methods, Partition methods, Hierarchical methods, Evaluation of clustering models. Association Rule: Structure of Association Rule, Apriori Algorithm

#Exemplar/Case Studies	Business applications for comparing the performance of a stock over a period of time https://cleartax.in/s/stock-market-analysis
***Mapping of Course Outcomes for Unit V**	CO3,CO5

Unit VI	**BI Applications**	**07 Hours**

Tools for Business Intelligence, Role of analytical tools in BI, Case study of Analytical Tools: WEKA, KNIME, Rapid Miner, R; Data analytics, Business analytics, ERP and Business Intelligence, BI and operation management, BI in inventory management system, BI and human resource management, BI Applications in CRM, BI Applications in Marketing, BI Applications in Logistics and Production, Role of BI in Finance, BI Applications in Banking, BI Applications in Telecommunications, BI in salesforce management

#Exemplar/Case Studies	Logistics planning in the food industry https://www.foodlogistics.com/case-studies https://www.barrettdistribution.com/food-distribution-case-study
***Mapping of Course Outcomes for Unit VI**	CO6

Learning Resources

Text Books :

1. Fundamental of Business Intelligence, Grossmann W, Rinderle-Ma, Springer,2015
2. R. Sharda, D. Delen, & E. Turban, Business Intelligence and Analytics. Systems for Decision Support, 10th Edition. Pearson/Prentice Hall, 2015.

Reference Books :

1. Paulraj Ponnian, "Data Warehousing Fundamentals", John Willey.
2. Introduction to business Intelligence and data warehousing, IBM, PHI
3. Business Intelligence: Data Mining and Optimization for Decision Making, Carlo Vercellis, Wiley,2019
4. Data Mining for Business Intelligence, Wiley
5. EMC Educational Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley ISBN-13 978 1118876138
6. Ken W. Collier, Agile Analytics: A value driven Approach to Business Intelligence and Data Warehousing, Pearson Education,2012, ISBN-13 978 8131786826

e-Books :

1. . https://www.knime.com/sites/default/files/inline-images/KNIME_quickstart.pdf
2. . www.cs.ccsu.edu/~markov/weka-tutorial.pdf
3. .http://www.biomedicahelp.altervista.org/Magistrale/Clinics/BIC_PrimoAnno/IdentificazioneModelliDataMining/Business%20Intelligence%20-%20Carlo%20Vercellis.pdf
4. https://download.e-bookshelf.de/download/0000/5791/06/L-G-0000579106-0002359656.pdf

MOOC Courses links :

NPTEL/YouTube video lecture links:

- Business Analytics for management decision : https://nptel.ac.in/courses/110105089
- Business analytics and data mining modeling using R : https://nptel.ac.in/courses/110107092
- Business Analysis for Engineers : https://nptel.ac.in/courses/110106050

@ The CO-PO Mapping Matrix

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

Savitribai Phule Pune University

Third Year of Computer Science and Design (2021 Course)

310255: Internship**

Teaching Scheme: ** Credit: 04 Examination Scheme: Term Work: 100 Marks

**

Course Objectives:

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

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

Course Outcomes:

On completion of the course, learners should be able to

CO1: To demonstrate professional competence through industry internship.
CO2: To apply knowledge gained through internships to complete academic activities in a professional manner.
CO3: To choose appropriate technology and tools to solve given problem.
CO4: To demonstrate abilities of a responsible professional and use ethical practices in day to day life.
CO5: Creating network and social circle, and developing relationships with industry people.
CO6: To analyze various career opportunities and decide 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, evidenceneeded to assign the points and the duration for certain activities.

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

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

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

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

- Depth of knowledge and skills
- Communication & Presentation Skills
- Team Work
- Creativity
- Planning & Organizational skills
- Adaptability
- Analytical Skills
- Attitude & Behavior at work

- Societal Understanding
- Ethics
- Regularity and punctuality
- Attendance record
- Diary/Work book
- Student's Feedback from External Internship Supervisor

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

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

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

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

- Title/Cover Page
- Internship completion certificate
- Internship Place Details- Company background-organization and activities/Scope and object of the study / Supervisor details
- Index/Table of Contents
- Introduction
- Title/Problem statement/objectives
- Motivation/Scope and rationale of the study
- Methodological details
- Results / Analysis /inferences and conclusion
- Suggestions / Recommendations for improvement to industry, if any
- Attendance Record
- Acknowledgement
- List of reference (Library books, magazines and other sources)

Feedback from internship supervisor (External and Internal)

Post internship, faculty coordinator should collect feedback about student with recommended parameters include as- Technical knowledge, Discipline, Punctuality, Commitment, Willingness to do the work, Communication skill, individual work, Team work, Leadership…..

Reference:

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

@ The CO-PO Mapping Matrix

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	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 and Design (2021 Course)

318255: Web Technology and Application Design Laboratory

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

Companion Course : Web Technology and Application Design (318252)

Course Objectives:

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

Course Outcomes:

On completion of the course, learners will be able to

CO1: Understand the importance of website planning and website design issues

CO2: Apply the client side and server side technologies for web application development

CO3: Analyze the web technology languages, frameworks and services

CO4: Create three tier web based applications

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal

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

Guidelines for Laboratory /Term Work Assessment

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

Guidelines for Oral Examination

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

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. Use of open source software is encouraged. Based on the concepts learned. Mini project should be implemented by the students in a group of 2-3 students.

Suggested List of Laboratory Experiments/Assignments

(All assignments are compulsory)

<table>
<tr><th>Sr. No.</th><th>Assignment Title</th></tr>
<tr><td>1.</td><td>Case study:
Before coding of the website, planning is important, students should visit different websites (Min. 5) for the different client projects and note down the evaluation results for these websites,either good website or bad website in following format:
<table>
<tr><th>Sr. No.</th><th>Website URL</th><th>Purpose of Website</th><th>Things liked in the website</th><th>Things disliked in the website</th><th>Overall evaluation of the website (Good/Bad)</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
From the evaluation, students should learn and conclude different website design issues, which should be considered while developing a website.</td></tr>
<tr><td>2.</td><td>Implement a web page index.htm for any client website (e.g., a restaurant website project) using following:
a. HTML syntax: heading tags, basic tags and attributes, frames, tables, images, lists, links for text and images, forms etc.
b. Use of Internal CSS, Inline CSS, External CSS</td></tr>
<tr><td>3.</td><td>Design the XML document to store the information of the employees of any business organization and demonstrate the use of:
a) DTD
b) XML Schema and display the content in (e.g., tabular format) by using CSS/XSL.</td></tr>
<tr><td>4.</td><td>Implement an application in Java Script using following:
a) Design UI of application using HTML, CSS etc.
b) Include Java script validation
c) Use of prompt and alert window using Java Script
e.g., Design and implement a simple calculator using Java Script for operations like addition, multiplication, subtraction, division, square of number etc.
a) Design calculator interface like text field for input and output, buttons for numbers and operators etc.
b) Validate input values
c) Prompt/alerts for invalid values etc.</td></tr>
<tr><td>5.</td><td>Implement the sample program demonstrating the use of Servlet.
e.g., Create a database table ebookshop (book_id, book_title, book_author, book_price, quantity) using database like Oracle/MySQL etc. and display (use SQL select query) the table content using servlet.</td></tr>
<tr><td>6.</td><td>Implement the program demonstrating the use of JSP.
e.g., Create a database table students_info (stud_id, stud_name, class, division, city) using database like Oracle/MySQL etc. and display (use SQL select query) the table content using JSP.</td></tr>
</table>

7.	Build a dynamic web application using PHP and MySQL. a. Create database tables in MySQL and create connection with PHP. b. Create the add, update, delete and retrieve functions in the PHP web app interacting with MySQL database
8.	Design a login page with entries for name, mobile number email id and login button. Use struts and perform following validations a. Validation for correct names b. Validation for mobile numbers c. Validation for email id d. Validation if no entered any value e. Re-display for wrongly entered values with message f. Congratulations and welcome page upon successful entries
9.	Design an application using Angular JS. e.g., Design registration (first name, last name, username, password) and login page using Angular JS.
10.	Design and implement a business interface with necessary business logic for any web application using EJB. e.g., Design and implement the web application logic for deposit and withdraw amount transactions using EJB.
11.	**Mini Project**: Design and implement a dynamic web application for any business functionality by using web development technologies that you have learnt in the above given assignments.

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University Third Year of Computer Science and Design (2021 Course) 318256: UI /UX Design Laboratory		
Teaching Scheme **Practical: 02 Hours/Week**	**Credit: 01**	**Examination Scheme and Marks** **Term Work: 25 Marks** **Oral: 25 Marks**
Companion Course: UI/UX Design (318253)		

Course Objectives:

- To study various tools of UI/UX Design
- To develop skills in creating visually appealing and cohesive user interfaces.
- To learn to conduct usability testing and evaluation
- To understand the role of prototyping in the design process
- To study collaborative features of UI/ UX Tool
- To gain awareness of ethical considerations in UI/UX design

Course Outcomes:

CO1: Apply user-centered design methodologies
CO2: Create effective user interfaces / user experiences
CO3: Develop proficiency in design tools
CO4: Design for multiple platforms and devices
CO5: Conduct usability testing and analysis
CO6: Develop a portfolio of UI/UX design projects

Suggested List of Laboratory Experiments /Assignments

(Perform Any 8 assignments from 1 to 14)

Supporting Video links are provided for reference

Sr. No.	Assignment Title
1	Study of various UI/UX design tools : Wireframe , Mockup , Figma Tools Identify specialized users and related facilities for a selected product /system and make necessary suggestions for its improved accessibility design • What is UI UX Design? | UI UX Design for Beginners | UI UX Design Certification Course | Edureka - YouTube
2	Design user persona for the users of selected product / system. • How To Create A User Persona (Video Guide) - YouTube • How to Create A User Persona in 2022 [FULL GUIDE] - YouTube
3	• Create Low-Fidelity and High Fidelity Wireframes: Start by sketching low-fidelity wireframes for each page using pen and paper or any digital tool you prefer. Focus on the layout, placement of key elements, and overall structure. Use basic shapes and placeholders to represent different elements such as navigation menus, search bars, images, buttons, and form fields. Aim for simplicity and clarity in your wireframes. • Refine High-Fidelity Wireframes: Transfer your low-fidelity wireframes to a digital wireframing tool such as Adobe XD, Sketch, Figma, or any other tool you are comfortable with. Create high-fidelity wireframes that incorporate more details, accurate text, and realistic representations of UI components. Pay attention to typography, color schemes, and spacing to improve visual hierarchy and user experience. • https://youtu.be/UU_eyUGWIEI
4	Online Learning Platform: Design a wireframe for an online learning platform that includes course listings, video lectures, quizzes, and progress tracking. • E-learning Website Design in Figma - YouTube

5	Designing a Social Fitness App: Create wireframes and a prototype for a social fitness app that allows users to track workouts, connect with friends, and share progress. Design the user interface for logging exercises, setting goals, and incorporating social features. • Fitness App Design In Figma || Figma Tutorial || Design & Prototyping - YouTube
6	Wireframes & Mockups: task is to create at least one wireframe, and one mockup of a web application. Your wireframe(s) and mockup will need to be responsive and take into account a desktop view and a mobile view. • UI / UX Design Tutorial – Wireframe, Mockup & Design in Figma - YouTube
7	Product Packaging Mockup: Choose a product and create a mockup of its packaging design. Use a mockup tool that specializes in packaging design or graphic design. Design the product packaging, including the layout, colors, logos, and product visuals.Showcase the packaging design from different angles and perspectives. • Packaging Mockup | Artboard Studio Mockups | Figma Tutorial - YouTube
8	Poster or Flyer Mockup: Select a specific event, campaign, or promotional material. Design a poster or flyer using a graphic design tool with mockup capabilities. Create a visually appealing mockup of the poster or flyer in different sizes and formats. Showcase the design within a realistic environment or context, such as a wall or display.
9	Use Figma tool for E-commerce Product Listing: Create a user interface for an e-commerce product listing page, with features like product images, descriptions, pricing, filters, sorting options, and add-to-cart functionality. • ECommerce Website UI Design | Figma - Part 1 - YouTube
10	Use Figma tool to Design a user interface for a recipe finder application, allowing users to search for recipes based on ingredients, categories, and dietary restrictions. Include features like recipe details, cooking instructions, and saving favorites. • Create a Food & Drink Recipe app with reviews from Figma no code - YouTube
11	Use Figma tool for Improving the User Interface of a Fitness Tracking App: Improve the user interface of an existing fitness tracking app by focusing on simplicity, clarity, and motivational elements. Enhance features like tracking workouts, setting goals, and visualizing progress to create a more engaging and intuitive experience. • Figma Fitness mobile app Design | design a Fitness app in Figma | UIUX Design 2021 | Techno-fine - YouTube
12	Collaborative Design Exercise: Form a design team and work on a collaborative design project using Figma. Assign different design tasks to team members, such as wireframing, visual design, or prototyping. Utilize Figma's collaboration features to work together in real-time.Coordinate and provide feedback to each other to refine and improve the design. • Create Teams in Figma & Real-Time Collaboration in Figma for Designers - YouTube
13	Usability Testing Simulation: Develop a high-fidelity interactive prototype using any UI/UX tool. Prepare a usability testing plan, recruit participants, and simulate usability testing sessions. Analyze the feedback and iterate on the design based on the insights gathered during the testing. • Usability Testing in UX Design Thinking Process - YouTube
14	Analyze an existing App and defining your Apps function step by step using Figma tool Evaluate an existing mobile banking application. Identify its strengths and weaknesses in terms of interface design. Discuss any legal issues that may be present, such as privacy concerns or compliance with regulations.

15	**Mini Project:** 1) Miniproject using Wireframes: Supply Chain Management: A web-based application designed to streamline and manage the supply chain process for a logistics company. It helps track and optimize the movement of goods from suppliers to customers ensuring efficiency and transparency throughout the supply chain. 2) Creating Social media advertisement using online tools and applications. 3) Case Study: Redesigning a Travel Booking Website 4) UI/UX Projects Ideas : Online Journal , A Chatbot, An App Layout for Smart Television

@ The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Third Year of Computer Science and Design (2021 Course)
318257: Laboratory Practice II

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

Companion Course: Artificial Intelligence (318251), Elective II (318254)

Course Objectives:

- To learn and apply various search strategies for AI
- To Formalize and implement constraints in search problems
- To understand the concepts of Multimedia Technique / Augmented and Virtual Reality/Cloud Computing/Business Intelligence and Data analytics

Course Outcomes:

On completion of the course, learner will be able to

- **Artificial Intelligence**
  - **CO1:** Design a system using different informed search / uninformed search or heuristic approaches
  - **CO2:** Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning
  - **CO3:** Design and develop an interactive AI application
- **Multimedia Technique**
  - **CO4:** Design and develop system using various multimedia components.
  - CO5: Use open source tools to create multimedia applications
  - CO6: Implement different coding techniques

OR

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

OR

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

OR

- **Business Intelligence and Data Analytics**
  - **CO4:** Design and develop applications on subjects of their choice.
  - **CO5:** Implement classification and clustering
  - **CO6:** Implement ETL process to construct database

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 theproblem statement. Relevant questions may be asked at the time of evaluation to test the student‘s understanding of the fundamentals, effective and efficient implementation. This will encourage, transparent evaluation and fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.

Guidelines for Laboratory Conduction

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

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

Programming tools recommended: -

Information Security : - C/C++/Java

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

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

Software Modeling and Architectures:-Front end:HTML5, Bootstarp, JQuery, JS etc.

Backend: MySQL /MongoDB/NodeJS

Part I : Artificial Intelligence

Suggested List of Laboratory Experiments/Assignments

Sr. No.	Group A All assignments are compulsory
1.	Implement depth first search algorithm and Breadth First Search algorithm, Use an undirected graph and develop a recursive algorithm for searching all the vertices of a graph or tree data structure.
2.	Implement A star Algorithm for any game search problem.
3.	Implement Greedy search algorithm for any of the following application: I. Selection Sort II. Minimum Spanning Tree III. Single-Source Shortest Path Problem IV. Job Scheduling Problem V. Prim's Minimal Spanning Tree Algorithm VI. Kruskal's Minimal Spanning Tree Algorithm VII. Dijkstra's Minimal Spanning Tree Algorithm

	Group B
4.	Implement a solution for a Constraint Satisfaction Problem using Branch and Bound and Backtracking for n-queens problem or a graph coloring problem.
5.	Develop an elementary catboat for any suitable customer interaction application.
	Group C
6.	Implement any one of the following Expert System I. Information management II. Hospitals and medical facilities III. Help desks management IV. Employee performance evaluation V. Stock market trading VI. Airline scheduling and cargo schedules
	Part II : Elective II
	Suggested List of Laboratory Experiments/Assignments
Sr. No.	**Assignment Name**
	Multimedia Technique **(All assignments are compulsory)**
1.	To study and install open-source multimedia tools and create an application using appropriate tool to design the college webpage
2.	Create or play a sample MIDI format sound file using LMMS / MuseScore / Tuxguitar software tool. Edit the sample file by applying effects like bend, slide, vibrato, and hammer-on/pull-off. Export / Convert final MIDI to WAV file format.
3.	Implement transform coding, quantization, and hierarchical coding for the encoder and decoder of three-level Hierarchical JPEG.
4.	To create JPEG Image that demonstrates various features of an Image editing tool.
5.	Create an immersive environment (living room/ battlefield/ tennis court) with only static game objects. 3D game objects can be created using Blender or use available 3D models.
6.	Create a web page for a clothing company which contains all the details of that company and at least five links to other web pages.
7	**Mini Project** **Mini Project:** Design and develop a Navigation Assistance System. **Mini Project:** Design and Develop a Traffic Monitoring System. **Mini Project:** Design and develop a Tool for converting image format (e.g. bmp to jpeg) **Mini Project:** Design and develop a Tool for converting audio format (e.g. wav to mp3)
	Cloud Computing **(All assignments are compulsory)**
1.	Case study on Microsoft azure to learn about Microsoft Azure is a cloud computing platform and infrastructure, created by Microsoft, for building, deploying and managing applications and services through a global network of Microsoft-managed data centers. OR Case study on Amazon EC2 and learn about Amazon EC2 web services.
2.	Installation and configure Google App Engine. OR Installation and Configuration of virtualization using KVM.
3.	Creating an Application in SalesForce.com using Apex programming Language.
4.	Design and develop custom Application (Mini Project) using Sales force Cloud.

5.	**Mini-Project** Setup your own cloud for Software as a Service (SaaS) over the existing LAN in your laboratory. In this assignment you have to write your own code for cloud controller using open-source technologies to implement **with HDFS**. Implement the basic operations may be like to divide the file in segments/blocks and upload/ download file on/from cloud in encrypted form.
	Augmented and Virtual Reality **(All assignments are compulsory)**
1.	Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
2.	Demonstration of the working of HTC Vive, Google Daydream or Samsung gear VR.
3.	Develop a scene in Unity that includes:
	i. A cube, plane and sphere, apply transformations on the 3 game objects. ii. Add a video and audio source.
4.	Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects. Change the color, material and texture of each Game object separately in the scene. Write a C# program in visual studio to change the color and Material/texture of the game objects dynamically on button click.
5.	Develop and deploy a simple marker based AR app in which you have to write a C# program to play video on tracking a particular marker.
6.	Develop and deploy an AR app, implement the following using Vuforia Engine developer portal: i. Plane detection ii. Marker based Tracking(Create a database of objects to be tracked in Vuforia) iii. Object Tracking
7.	**Mini-Projects/ Case Study** Create a multiplayer VR game (battlefield game). The game should keep track of score, no. of chances/lives, levels (created using different scenes), involve interaction, animation and immersive environment. **OR** Create a treasure hunt AR application which should have the following features: i. A help button for instruction box to appear. ii. A series of markers which would give hints on being scanned. iii. Involve interaction, sound, and good UI.
	Business Intelligence and Data Analytics **(All assignments are compulsory)**
1.	Import the legacy data from different sources such as (Excel, Sql Server, Oracle etc.) and load in the target system. (You can download sample database such as Adventure works, Northwind, foodmart etc.)
2.	Perform the Extraction Transformation and Loading (ETL) process to construct the database in the Sql server.
3.	Create the cube with suitable dimension and fact tables based on ROLAP, MOLAP and HOLAP model.
4.	Import the data warehouse data in Microsoft Excel and create the Pivot table and Pivot Chart
5	Perform the data classification using classification algorithm. Or Perform the data clustering using clustering algorithm.

6	**Mini Project**: Each group of 4 Students (max) assigned one case study for this; A BI report must be prepared outlining the following steps: a) Problem definition, identifying which data mining task is needed. b) Identify and use a standard data mining dataset available for the problem.

@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 Computer Science and Design (2021 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 levelitself [1]

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

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

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

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

Audit Course 6 Options

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

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

Savitribai Phule Pune University

Third Year Computer Science and Design (2021 Course)

Audit Course 6

310259(A): Digital and Social Media Marketing

Prerequisites: Internet Technologies

Course Objectives:

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

Course Outcomes:

On completion of the course, learners will be able to

CO1: Understand the fundamentals and importance of digital marketing

CO2: Use the power of social media for business marketing

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

Course Contents

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

Reference Books :

1. Avery Swartz, “See You on the Internet: building your small business with Digital Marketing”, ISBN 978-1-989603-08-6.
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	-	-	-	-	-

Savitribai Phule Pune University

Third Year Computer Science and Design (2021 Course)

Audit Course 6

310259(B): 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

Savitribai Phule Pune University

Third Year Computer Science and Design (2021 Course)

Audit Course 6

310259(C): Leadership and Personality Development

Prerequisites: General awareness of communication and relationship.

Course Objectives:

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

Course Outcomes:

On completion of the course, learners will be able to

CO1: Express effectively through communication and improve listening skills

CO3: Develop **e**ffective 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 Clarityof 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, Bharadwaj G (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

Savitribai Phule Pune University

Third Year Computer Science and Design (2021 Course)

Audit Course 6

310259(D): Foreign Language (Japanese) Module 4

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

Course Objectives:

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

Course Outcomes:

On completion of the course, learner will be able to

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

CO2: Understand the nature of Japanese script

CO3: Get introduced to reading, writing and listening skills

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

Course Contents

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

Reference Books :

1. Minna No Nihongo, “Japanese for Everyone”, Elementary MainTextbook1-1(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	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	-	1	3	1	1
CO2	-	-	-	-	1	-	-	-	-	3	1	1
CO3	-	-	-	-	1	-	-	-	-	3	2	2
CO4	-	-	-	-	-	-	-	-	-	1	-	1

Savitribai Phule Pune University

Third Year Computer Science and Design (2021 Course)

Audit Course 6

310259(E): Learn New Skill- 'Software Development Using Agility Approach'

Prerequisites: Software Engineering (210253)

Course Objectives:

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

Course Outcomes:

On completion of the course, learner will be able to

CO1: Illustrate the agility and principles

CO2: Understand the software development using agile methodology

CO3: Apply Dev Ops for the software product development

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

Course Contents

1. **THE THREE WAYS: Agile**, continuous delivery and the three ways, The First Way: The Principles of Flow, The Second Way: The 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 Dev Ops Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations"
2. Len Bass, Ingo Weber, Liming Zhu, "Dev Ops: A Software Architect's Perspective " Publisher(s): Addison-Wesley Professional, ISBN: 9780134049885

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

@The CO-PO Mapping Matrix

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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

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