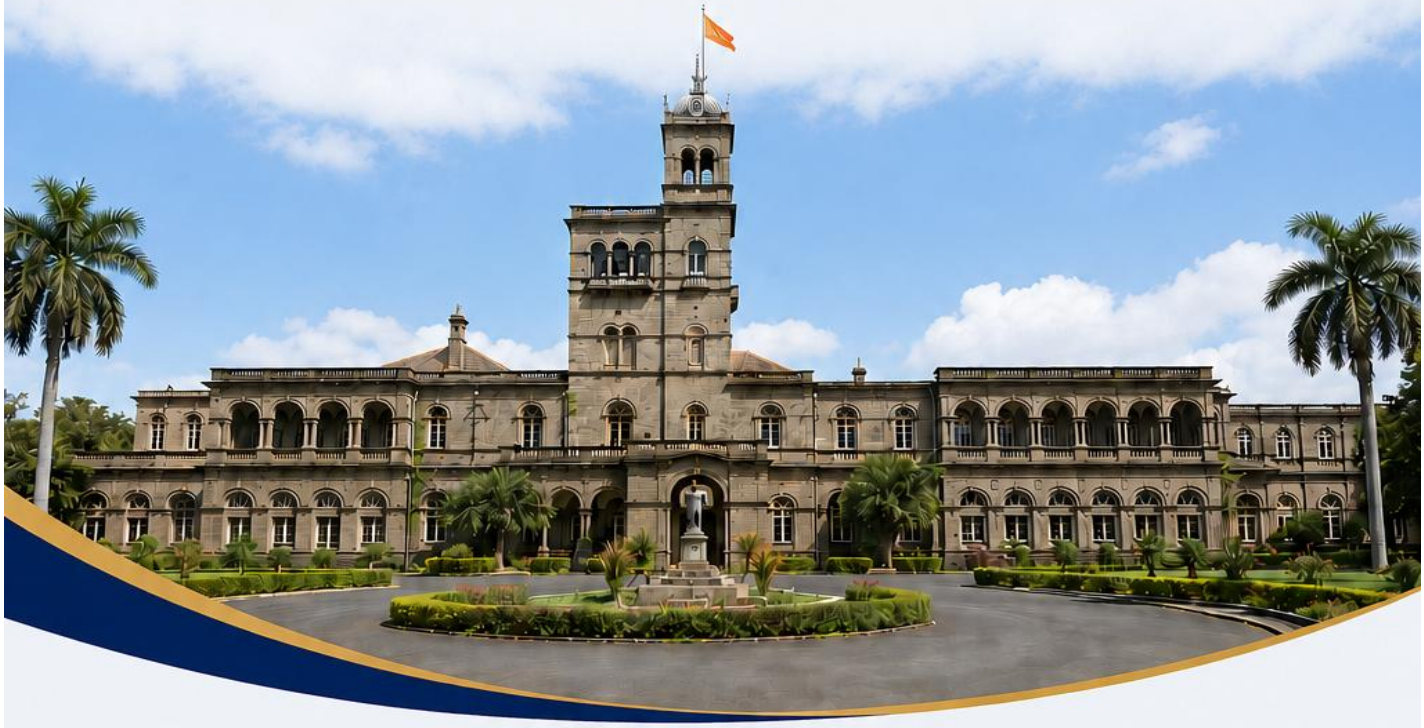
॥ योः क्रियावानू स पण्डितः ॥

SAVITRIBAI PHULE PUNE UNIVERSITY

(सावित्रीबाई फुले पुणे विद्यापीठ)

Formerly University of Pune



Syllabus Booklet

For

B.E.

(COMPUTER SCIENCE)

— 2019 PATTERN —

With effect from Academic Year 2026-27

Final Year of Computer Science (2019 Course)

Prologue

Dear Students, Faculty Members, and Academic Partners,

It is with great pride, responsibility, and professional fulfillment that I present the revised curriculum structure and detailed syllabi for the **Final Year of Computer Engineering (2019 Pattern)**, effective from the Academic Year 2026-27, on behalf of the Board of Studies (BoS), Savitribai Phule Pune University.

As computer technology evolves at an exponential rate, designing an academic framework demands a highly proactive approach. This curriculum revision has been formulated at a historic juncture where generative artificial intelligence, decentralized computing, immersive environments, and big data are redefining global industrial operations. The challenge before the Board was clear: to craft a curriculum that strikes a harmonious equilibrium between timeless computational fundamentals and advanced, disruptive engineering domains.

This final draft is the collective outcome of intense deliberation, rigorous peer review, and active participation. I extend my deepest gratitude to all the eminent industry experts, visionary academicians, committed alumni, and hard-working members of the Board of Studies who lent their intellect and adroit effort to bring this booklet to fruition.

Dr. Nilesh J. Uke
Chairman, Board of Studies (Computer Engineering)
Savitribai Phule Pune University, Pune

Savitribai Phule Pune University

Final Year of Computer Science (2019 Course)

(With effect from Academic Year 2026-27)

Table of Contents

Savitribai Phule Pune University
B.E. (Computer Science)
Program Outcomes (POs)

Learners are expected to know and be able to–

PO1	Engineering knowledge	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO2	Problem analysis	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3	Design / Development of Solutions	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO4	Conduct Investigations of Complex Problems	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO5	Engineering Tool Usage	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO6	The Engineer and The World	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	Individual and Collaborative Team work	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	Communication	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	Life-Long Learning	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Program Specific Outcomes (PSO)

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

Curriculum structure

Savitribai Phule Pune University
Final Year of Computer Science (2019 Course)
(With effect from Academic Year 2026-27)

Semester VII

Course Code	Course Name	Teaching Scheme (Hours/week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	Mid-Sem	End-Sem	Term work	Practical	Oral\Pre	Total	Lecture	Practical	Tutorial	Total
410641	Compiler Design	03	-	-	30	70	-	-	-	100	3	-	-	3
410242	Machine Learning	03	-	-	30	70	-	-	-	100	3	-	-	3
410243	Blockchain Technology	03	-	-	30	70	-	-	-	100	3	-	-	3
410244	Elective III	03	-	-	30	70	-	-	-	100	3	-	-	3
410245	Elective IV	03	-	-	30	70	-	-	-	100	3	-	-	3
410646	Laboratory Practice V	-	04	-	-	-	50	50	-	100	-	2	-	2
410647	Laboratory Practice VI	-	02	-	-	-	50	-	-	50	-	1	-	1
410248	Project Stage I	-	02	-	-	-	50	-	-	50	-	2	-	2
										Total Credit	**15**	**05**	**-**	**20**
Total		**15**	**08**	**-**	**150**	**350**	**150**	**50**	**-**	**700**	**15**	**05**	**-**	**20**
410249	Audit Course 7										**Grade**			

Elective III	**Elective IV**
410244(A) Pervasive Computing 410244(B) Multimedia Techniques 410244(C) Cyber Security and Digital Forensics 410244(D) Object Oriented Modeling and Design 410644E: Social Network Analysis and Mining_	410245(A) Information Retrieval 410245(B) GPU Programming and Architecture 410245(C) Mobile Computing 410245(D)Software Testing and Quality Assurance 410645E:AWS_Cloud_Application_Engineering_
Laboratory Practice V: Laboratory assignments Courses- 410641, 410242, 410243	**Laboratory Practice VI:** Laboratory assignments Courses- 410244, 410245

Audit Course 7(AC7) Options:
AC7- I MOOC- Learn New Skills
AC7- II Entrepreneurship Development
AC7- III Botnet of Things
AC7- IV 3D Printing
AC7- V Industrial Safety and Environment Consciousness

Savitribai Phule Pune University
Final Year of Computer Science (2019 Course)
(With effect from Academic Year 2026-27)

Semester VIII

Course Code	Course Name	Teaching Scheme (Hours/week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	Mid-Sem	End-Sem	Term work	Practical	Oral/Pre	Total	Lecture	Practical	Tutorial	Total
410650	Quantum Computing	03	-	-	30	70	-	-	-	100	03			03
410251	Deep Learning	03	-	-	30	70	-	-	-	100	03			03
410252	Elective V	03	-	-	30	70	-	-	-	100	03			03
410253	Elective VI	03	-	-	30	70	-	-	-	100	03			03
410254	Laboratory Practice VI	-	02	-	-	-	50	50	-	100		01		01
410255	Laboratory Practice VIII	-	02	-	-	-	50	-	-	50		01		01
410256	Project Stage II	-	06	-	-	-	100	-	50	150		06		06
										Total Credit	**12**	**08**	**-**	**20**
	Total	**12**	**10**	**-**	**120**	**280**	**200**	**50**	**50**	**700**	**12**	**08**	**-**	**20**
410257	Audit Course 8										**Grade**			

Elective V	**Elective VI**
410252(A) Natural Language Processing 410252(B) Image Processing 410252(C) Software Defined Networks 410652(D) Wireless Sensor Network 410252(E) Open Elective	410253(A) Pattern Recognition 410253(B) Soft Computing 410253(C) Business Intelligence 410653(D) Reinforcement Learning 410253(E) Open Elective
Lab Practice VII: Laboratory assignments Courses- 410650, 410251 or 410652(D)	**Lab Practice VIII:** Laboratory assignments Courses- 410252, 410253 or 410653(D)

Audit Course 8(AC8) Options:
AC8- I Usability Engineering
AC8- II Conversational Interfaces
AC8- II Social Media and Analytics
AC8- IV MOOC- Learn New Skills
AC8- V Emotional Intelligence

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 times are generic and bundled. The **Course Objectives**, **Course Outcomes** and **CO-PO mappings matrix** justifies the motives, accomplishment and prospect behind learning the course. The Course Objectives, Course Outcomes and CO-PO Mapping Matrix are provided for reference and these are indicative only. The course instructor may modify them as per his or her perspective.

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

3. For each course, contents are divided into six units-I, II, III, IV, V and VI.

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

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

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

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

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

8.For laboratory, instructions have been included about the conduction and assessment of laboratory work. These guidelines are to be strictly followed.

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

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

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

SEMESTER VII

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410241: Compiler Design

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

Prerequisites Courses: Discrete Mathematics (210241), Fundamentals of Data Structures(210242, Data Structures and Algorithms(210252), Theory of Computation (310242)

Companion Course: Laboratory Practice III(410246)

Course Objectives:

- To understand the overview and translation process of a compiler and its various phases.
- To design and implement a Lexical Analyzer using regular expressions and finite automata.
- To apply top-down and bottom-up parsing techniques and understand parser generators.
- To study error detection and recovery strategies used in compilers.
- To understand intermediate code generation using syntax-directed translation schemes.
- To explore run-time memory management, storage allocation strategies, and symbol tables.
- To apply code optimization and code generation techniques for efficient target code.

Course Outcomes:

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

CO1: **Understand** the basic concepts and applications of Compiler Design
CO2: Design a Lexical Analyzer using regular expressions, finite automata, and DFA optimization.
CO3: Design and implement parsers using top-down and bottom-up strategies.
CO4: Understand error recovery mechanisms and generate intermediate code.
CO5: Apply run-time memory management strategies including storage allocation.
CO6: Design and implement code optimization and code generation algorithms.

Course Contents

Unit I	Introduction to Compiler Design	07 Hours

Overview of the Translation Process, A Simple Compiler, Difference between interpreter, assembler and compiler. Overview and use of linker and loader, types of Compiler, Analysis of the Source Program, The Phases of a Compiler, Cousins of the Compiler, The Grouping of Phases, Lexical Analysis, Hard Coding and Automatic Generation Lexical Analyzers, Front-end and Back-end of compiler, pass structure

#Exemplar/Case Studies	GCC (GNU Compiler Collection), LLVM Compiler Infrastructure
***Mapping of Course Outcomes for Unit I**	CO1,CO3

Unit II	Lexical Analyzer	07 Hours

Lexical Analyzer: Introduction to Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, A Language for Specifying Lexical Analyzers, Finite Automata From a Regular Expression, Design of a Lexical Analyzer Generator, Optimization of DFA.

#Exemplar/Case Studies	Lex / Flex Tool in Real Compilers, DFA Optimization in Industrial Compilers

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

Unit III	**Parsing Theory**	**08 Hours**

Parsing: Top Down and Bottom up Parsing Algorithms, Top-Down Parsing, Bottom-Up Parsing, Operator-Precedence Parsing, LR Parsers, Using Ambiguous Grammars, Parser Generators, Automatic Generation of Parsers. Syntax-Directed Definitions, Construction of Syntax Trees, Bottom-Up Evaluation of S-Attributed Definitions, L-Attributed Definitions, syntax directed definitions and translation schemes

#Exemplar/Case Studies	YACC/Bison in Real-World Parsers, Syntax-Directed Translation in SQL Parsers
***Mapping of Course Outcomes for Unit III**	CO3, CO4

Unit IV	**Error Recovery & Intermediate Code Generation**	**07 Hours**

Error Recovery: Error Detection & Recovery, Ad-Hoc and Systematic Methods, **Intermediate Code Generation:** Different Intermediate Forms, Syntax Directed Translation Mechanisms And Attributed Mechanisms And Attributed Definition.

#Exemplar/Case Studies	Error Recovery in GCC and Clang, Three-Address Code in LLVM IR, Backpatching in Java Bytecode Generation
***Mapping of Course Outcomes for Unit IV**	CO3, CO4

Unit V	**Run-Time Memory Management & Symbol Tables**	**07 Hours**

Run Time Memory Management: Source Language Issues, Storage Organization, Storage-Allocation Strategies, and Access to Non local Names, Parameter Passing, Symbol Tables, and Language Facilities for Dynamic Storage Allocation, Dynamic Storage Allocation Techniques.**Symbol Tables:** Purpose and structure of the symbol table, Symbol table entries: name, type, scope, memory location, and other attributes, Implementation methods: linear list, hash tables, binary search trees, Handling nested scopes and block-structured languages

#Exemplar/Case Studies	Stack Frame Layout in x86-64 (System V ABI), Symbol Table in GCC: DWARF Debug Information
***Mapping of Course Outcomes for Unit V**	CO3,CO5

Unit VI	**Code Optimization & Code Generation**	**08 Hours**

Code Optimization: Global Data Flow Analysis, A Few Selected Optimizations like, Command Sub Expression Removal, Loop Invariant Code Motion, Strength Reduction etc. **Code Generation** Issues in the Design of a Code Generator, The Target Machine, Run-Time Storage Management, Basic Blocks and Flow Graphs, Next-Use Information, A Simple Code Generator, Register Allocation and Assignment, The DAG Representation of Basic Blocks, Peephole Optimization, Generating Code from DAGs, Dynamic Programming Code-Generation Algorithm, Code-Generator Generators.

#Exemplar/Case Studies	Loop Optimizations in GCC (-O2 / -O3 Flags), Register Allocation: LLVM vs. GCC,

	Code Generator for a Virtual Machine Code based JavaScript Compiler (http://article.nadiapub.com/IJAST/vol119/11.pdf)

***Mapping of Course Outcomes for UnitVI**	CO6

Learning Resources

Text Books:

1. V Aho, R Sethi, J D Ullman, "Compilers: Principles, Techniques, and Tools", Pearson Edition, ISBN 81-7758-590-8
2. Dick Grune, Bal, Jacobs, Langendoen, " Modern Compiler Design", Wiley, ISBN 81-265-
3. Cooper, K. D. & Torczon, L. — Engineering a Compiler, Morgan Kaufmann Publishers, 2nd Edition, 2011.
4. Muchnick, S. — Advanced Compiler Design and Implementation, Morgan Kaufmann Publishers, 1997.

Reference Books :

1. Aho, A., Lam, M., Sethi, R. & Ullman, J. — Compilers: Principles, Techniques and Tools, Second Edition, Pearson Education, 2014.
2. Aho, A., Sethi, R. & Ullman, J. — Compilers: Principles, Techniques and Tools, Addison-Wesley, 1986.
3. Holub, Allen I. — Compiler Design in C, Prentice-Hall / Pearson.
4. Muchnick, S. S. — Advanced Compiler Design and Implementation, Morgan Kaufmann, 1998.
5. Anthony J. Dos Reis, "Compiler Construction Using Java", JavaCC and Yacc Wiley, ISBN 978-0-470-94959-7
6. K Muneeswaran, "Compiler Design", Oxford University press, ISBN 0-19-806664-3
7. J R Levin, T Mason, D Brown, "Lex and Yacc", O'Reilly, 2000 ISBN 81-7366-061-X

e-Books :

1. Basics of Compiler Design http://hjemmesider.diku.dk/~torbenm/Basics/basics_lulu2.pdf

2. Modern Compiler Design

http://160592857366.free.fr/joe/ebooks/ShareData/Modern%20Compiler%20Design%202e.pdf

MOOC Courses links :

https://nptel.ac.in/courses/106105190

@The CO-PO Mapping Matrix

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

3 – High Correlation 2 – Medium Correlation 1 – Low Correlation – No Correlation

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410242: Machine Learning

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

Prerequisite Courses: Data Science and Big Data Analytics(310251)

Companion Course: Laboratory Practice III(410246)

Course Objectives:

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

Course Outcomes:

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

CO1: Identify the needs and challenges of machine learning for real time applications.
CO2: Apply various data pre-processing techniques to simplify and speed up machine learning algorithms.
CO3: Select and apply appropriately supervised machine learning algorithms for real timeapplications.
CO4: Implement variants of multi-class classifier and measure its performance.
CO5 :Compare and contrast different clustering algorithms.
CO6: Design a neural network for solving engineering problems.

Course Contents

Unit I	Introduction To Machine Learning	07 Hours

Introduction to Machine Learning, Comparison of Machine learning with traditional programming, ML vs AI vs Data Science.
Types of learning: Supervised, Unsupervised, and semi-supervised, reinforcement learning techniques, Models of Machine learning: Geometric model, Probabilistic Models, Logical Models, Grouping and grading models, Parametric and non-parametric models.
Important Elements of Machine Learning- Data formats, Learnability, Statistical learning approaches

#Exemplar/Case Studies	Suppose you are working for Uber where a task to increase sales is given.Understand the requirements of the client
*Mapping of Course Outcomes for Unit	CO1

Unit II	Feature Engineering	07 Hours

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

#Exemplar/CaseStudies	You are a Data Scientist, and a client comes to you with their data. Client is running a few campaigns from the past few months, but no campaign seemseffective. Client provides you the data of customers, product sales and past campaign success. They want to increase their sales and figure out which marketing strategy isworking the best for them? Questions for data scientists: 1. What data analysis approach will you follow? 2. What statistical approach do you need to follow? How will you select important features?
***Mapping of Course Outcomes for Unit II**	CO2

Unit III	**Supervised Learning : Regression**	**06 Hours**

Bias, Variance, Generalization, Underfitting, Overfitting, Linear regression, Regression: Lasso regression, Ridge regression, Gradient descent algorithm.
Evaluation Metrics: MAE, RMSE, R2

#Exemplar/Case Studies	Stock market price prediction
***Mapping of Course Outcomes for Unit III**	CO3

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

Classification: K-nearest neighbour, Support vector machine.
Ensemble Learning: Bagging, Boosting, Random Forest,
Adaboost.
Binary-vs-Multiclass Classification, Balanced and Imbalanced Multiclass Classification Problems,Variants of Multiclass Classification: One-vs-One and One-vs-All
Evaluation Metrics and Score: Accuracy, Precision, Recall, Fscore, Cross-validation, Micro-Average Precision and Recall, Micro-Average F-score, Macro-Average Precision and Recall, Macro-Average F-score.

#Exemplar/Case Studies	Prediction of Thyroid disorders such as Hyperthyroid, Hypothyroid, Euthyroid-sick,and Euthyroid using multiclass classifier.
***Mapping of Course Outcomes for Unit IV**	CO4

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

K-Means, K-medoids, Hierarchical, and Density-based Clustering, Spectral Clustering. Outlier analysis: introduction of isolation factor, local outlier factor.
Evaluation metrics and score: elbow method, extrinsic and intrinsic methods

#Exemplar/Case Studies	Market basket analysis/Customer Segmentation
*Mapping of Course Outcomes for Unit V	CO5

Unit VI	Introduction To Neural Networks	07 Hours

Artificial Neural Networks: Single Layer Neural Network, Multilayer Perceptron, Back Propagation Learning, Functional Link Artificial Neural Network, and Radial Basis Function Network, Activation functions,
Introduction to Recurrent Neural Networks and Convolutional Neural Networks

#Exemplar/Case Studies	Movie Recommendation System
*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. Bishop, Christopher M., and Nasser M. Nasrabadi, "Pattern recognition and machine learning",Vol. 4.No. 4. New York: springer, 2006.
2. Ethem Alpaydin, " Introduction to Machine Learning", PHI 2nd Edition-2013

Reference Books:

1. Tom Mitchell, " Machine learning", McGraw-Hill series in Computer Science, 1997
2. Shalev-Shwartz, Shai, and Shai Ben-David, "Understanding machine learning: From theory toalgorithms", Cambridge university press, 2014.
3. Jiawei Han, Micheline Kamber, and Jian Pie, "Data Mining: Concepts and Techniques", Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807
4. Hastie, Trevor, et al., "The elements of statistical learning: data mining, inference, and prediction", Vol. 2. New York: springer, 2009.
5. McKinney, "Python for Data Analysis ",O' Reilly media, ISBN : 978-1-449-31979-3
6. Trent hauk, "Scikit-learn", Cookbook , Packt Publishing, ISBN: 9781787286382
7. Goodfellow I.,Bengio Y. and Courville, " A Deep Learning", MIT Press, 2016

e-Books :

1. Python Machine Learning : http://www.ru.ac.bd/wp-content/uploads/sites/25/2019/03/207_05_01_Rajchka_Using-Python-for-machine-learning-2015.pdf
2. Foundation of Machine Learning: https://cs.nyu.edu/~mohri/mlbook/
3. Dive into Deep Learning: http://d2l.ai/
4. A brief introduction to machine learning for Engineers: https://arxiv.org/pdf/1709.02840.pdf
5. Feature selection: https://dl.acm.org/doi/pdf/10.5555/944919.944968
6. Introductory Machine Learning Nodes : http://lcsl.mit.edu/courses/ml/1718/MLNotes.pdf

MOOC Courses Links:

- Introduction to Machine Learning : https://nptel.ac.in/courses/106105152
- Introduction to Machine Learning (IIT Madras): https://onlinecourses.nptel.ac.in/noc22_cs29/prevew
- Deep learning: https://nptel.ac.in/courses/106106184

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410243: Block chain Technology

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

Prerequisite Courses: Computer Networks and Security(310244)

Companion Course: Laboratory Practice III(410246)

Course Objectives:

- Technology behind Blockchain
- Crypto currency, Bitcoin and Smart contracts
- Different consensus algorithms used in Blockchain
- Real-world applications of Blockchain
- To analyze Blockchain Ethereum Platform using Solidity
- To Describe Blockchain Case Studies

Course Outcomes:

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

CO1: Interpret the fundamentals and basic concepts in Blockchain
CO2: Compare the working of different blockchain platforms
CO3: Use Crypto wallet for cryptocurrency based transactions
CO4: Analyze the importance of blockchain in finding the solution to the real-world problems.
CO5: Illustrate the Ethereum public block chain platform
CO6: Identify relative application where block chain technology can be effectively used andimplemented.

Course Contents

Unit I	Mathematical Foundation for Block chain	06 Hours

Cryptography: Symmetric Key Cryptography and Asymmetric Key Cryptography, Elliptic Curve Cryptography (ECC), Cryptographic Hash Functions: SHA256, Digital Signature Algorithm (DSA), Merkel Trees.

#Exemplar/Case Studies	Compare the Symmetric and Asymmetric Cryptography algorithms
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Feature Engineering	07 Hours

History, Centralized Vs. Decentralized Systems, Layers of Blockchain: Application Layer, Execution Layer, Semantic Layer, Propagation Layer, Consensus Layer, Why is Block chain important? Limitations of Centralized Systems, Blockchain Adoption So Far.

#Exemplar/CaseStudies	Study of a research paper based on Blockchain.
*Mapping of Course Outcomes for Unit II	CO1

Unit III	Blockchain Platforms and Consensus in Blockchain	06 Hours

Types of Blockchain Platforms: Public, Private and Consortium, Bitcoin, Ethereum, Hyperledger,IoTA, Corda, R3.
Consensus in Blockchain: Consensus Approach, Consensus Elements, Consensus Algorithms, Proof of Work, Byzantine General problem, Proof of Stake, Proof of Elapsed Time, Proof of Activity, Proof of Burn.

#Exemplar/Case Studies	Compare different consensus algorithms used in Blockchain Technology.
*Mapping of Course Outcomes for Unit III	CO2

Unit IV	Cryptocurrency – Bitcoin, and Token	06 Hours

Introduction, Bitcoin and the Cryptocurrency, Cryptocurrency Basics Types of Cryptocurrency, Cryptocurrency Usage, Cryptowallets: Metamask, Coinbase, Binance

#Exemplar/Case Studies	Create your own wallet for crypto currency using any of the Blockchain Platforms.
*Mapping of Course Outcomes for Unit IV	CO3

Unit V	Blockchain Ethereum Platform using Solidity	06 Hours

What is Ethereum, Types of Ethereum Networks, EVM (Ethereum Virtual Machine), Introduction to smart contracts, Purpose and types of Smart Contracts, Implementing and deploying smart contracts using Solidity, Swarm (Decentralized Storage Platform),
Whisper (Decentralized Messaging Platform)

#Exemplar/Case Studies	Study Truffle Development Environment.
*Mapping of Course Outcomes for Unit V	CO4

Unit VI	Blockchain Case Studies	06 Hours

Prominent Blockchain Applications, Retail, Banking and Financial Services, Government Sector, Healthcare, IOT, Energy and Utilities, Blockchain Integration with other Domains

#Exemplar/Case Studies	Study 2 uses cases of Blockchain and write a detailed report on every aspect implemented in the same
*Mapping of Course Outcomes for Unit VI	CO5, CO6

Learning Resources

Text Books:

1. Martin Quest, "Blockchain Dynamics: A Quick Beginner's Guide on Understanding the Foundations of Bit coin and Other Crypto currencies", Create Space Independent PublishingPlatform, 15-May-2018
2. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained", Second Edition, Packt Publishing, 2018
3. Alex Leverington, "Ethereum Programming", Packt Publishing, 2017

Reference Books:

1. Bikramaditya Singhal, Gautam Dhameja, Priyansu Sekhar Panda, "Beginning Blockchain ABeginner's Guide to Building Blockchain Solutions",2018
2. Chris Dannen, "Introducing Ethereum and Solidity", Foundations of Crypto currency andBlockchain Programming for Beginners
3. Daniel Drescher, "Blockchain Basics", A Non -Technical Introduction in 25Steps.
4. Ritesh Modi, "Solidity Programming Essentials", Packt Publishing,2018
5. Chandramouli Subramanian, Asha A George, Abhilash K A and Meena Karthikeyan, "Blockchain Technology", Universities Press, ISBN-9789389211634

e-Books :

1. https://users.cs.fiu.edu/~prabakar/cen5079/Common/textbooks/Mastering_Blockchain_2nd_Edition.pdf
2. https://www.lopp.net/pdf/princeton_bitcoin_book.pdf
3. https://www.blockchainexpert.uk/book/blockchain-book.pdf

MOOC Courses Links:

1. NPTEL Course on "Introduction to Blockchain Technology & Applications" https://nptel.ac.in/courses/106/104/106104220/
2. NPTEL Course on **b** https://nptel.ac.in/courses/106/105/106105184/

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410244(A): Pervasive Computing

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

Prerequisite Courses: -Internet of Thigs and Embedded Systems(310245A)

Companion Course: Laboratory Practice IV(410247)

Course Objectives:

- To introduce the characteristics, basic concepts and systems issues in pervasivecomputing.
- To illustrate smart devices and architectures in pervasive computing.
- To introduce intelligent systems and interactions in Pervasive computing.
- To identify the trends and latest development of the technologies in the area.
- To Understand Interaction Design – HCI and Wearable Computing Environment.
- To identify Security Challenges & Ethics in Pervasive Computing

Course Outcomes:

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

CO1.Demonstrate fundamental concepts in pervasive computing.
CO2.Explain pervasive devices and decide appropriate one as per the need of real timeapplications.
CO3.Classify and analyze context aware systems for their efficiency in different ICT systems.
CO4.Illustrate intelligent systems and generic intelligent interactive applications.
CO5.Design HCI systems in pervasive computing environment.
CO6.Explore the security challenges and know the role of ethics in the context of pervasivecomputing.

Course Contents

Unit I	Introduction To Pervasive Computing	07 Hours

Pervasive Computing: History, Principles, Characteristics, Problems/Issues & Challenges, Advantages of Pervasive Computing

Pervasive Computing Applications: Pervasive computing devices and interfaces, Device technology trends, Connecting issues and protocols.

#Exemplar/Case Studies	Pervasive Computing for Personalized medicine
*Mapping of Course Outcomes for Unit I	**CO1**

Unit II	Smart Computing with Pervasive Computing Devices	07 Hours

Smart Devices: CCI, Smart Environment: CPI and CCI, Smart Devices: iHCI and HPI, Wearable devices, Application and Requirements, Device Technology and Connectivity, PDA Device characteristics - PDA Based Access Architecture, Voice Enabling Pervasive Computing: Voice Standards, Speech Applications in Pervasive Computing.

#Exemplar/CaseStudies	Amazon Alexa

*Mapping of Course Outcomes for Unit II	CO2

Unit III	Context Aware Systems	07 Hours

Introduction, Types of Context, Context Aware Computing and Applications, Modelling Context-Aware Systems, Mobility awareness, spatial awareness, temporal awareness: Coordinating and scheduling, ICT system awareness, Middleware Support

#Exemplar/Case Studies	Mobile Hanging Services systems
*Mapping of Course Outcomes for Unit III	CO3

Unit IV	Intelligent Systems and Interaction	07 Hours

Introduction, Basic Concepts, IS Architectures, Semantic KBIS, Classical Logic IS, Soft Computing IS Models, IS System Operations, Interaction Multiplicity, IS Interaction Design, Generic Intelligent Interaction Applications.

#Exemplar/Case Studies	Curious information displays: A motivated reinforcement learning IE application.
*Mapping of Course Outcomes for Unit IV	CO4

Unit V	User Interaction Design – HCI and Wearable Computing	07 Hours

Introduction of Interaction Design, Basics of Interaction Design and its Concepts, Importance of Interaction Design, Difference between Interaction Design and UX. What is HCI? Importance of HCI, Advantages and Disadvantages of HCI, Elements of HCI, HCI Design and Architecture,Define Wearable Computing, Importance of Wearable Computing, Security issues in Wearable Computing, Wearable Computing Architecture and Applications, Wearable Computing Challenges and Opportunities for Privacy Protection

#Exemplar/Case Studies	Smart Fabric/ Textile, Sensory Fabric for Ubiquitous interfaces
*Mapping of Course Outcomes for Unit V	CO5

Unit VI	Security Challenges & Ethics in Pervasive Computing	07 Hours

Security issues in Pervasive Computing: security model, authentication & authorization, access control, secure resource discovery, open issues.Pervasive computing security challenges & requirements: Privacy & trust issues, social & user interaction issues, solution for pervasive computing challenges, Role of Ethics in pervasive computing security: Autonomy and Self-determination, Responsibility: legal, moral & social, distributive justice, digital divide and sustainable development

#Exemplar/Case Studies	Pervasive Computing Security Gaia Project
*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. Stefan Poslad, "Ubiquitous Computing: Smart Devices: Environments and Interactions", Wiley Publication, Student Edition, ISBN 9788126527335.
2. Jochen Burkhardt, Horst Henn, Stefan Hepper, Klaus Rindtroff, Thomas Schack, " Pervasive Computing: Technology and Architecture of Mobile Internet Applications", Pearson Education, ISBN 9788177582802
3. Frank Adelstein, Sandeep K. S. Gupta, Golden G. Richard III, Loren Schwiebert, "Fundamentals of Mobile and Pervasive Computing" McGraw Hill Education, Indian Edition, ISBN 9780070603646

Reference Books:

1. Sen Loke, "Context Aware Pervasive Systems; Architectures for new Breed of applications",Taylor and Fransis, ISBN 0-8493-7255-0
2. LaurnceYang, Evi Syukur, Seng Loke, "Handbook on Mobile and Ubiquitous Computing : Status and Perspective‖", CRC Press, 2013 ISBN 978-1-4398-4811-1
3. M. Haque and S. I. Ahamed, "Security in pervasive computing: Current status and open issues",
Int. J. Netw. Secur., vol. 3, no. 3, pp. 203–214, 2006.

e-Books :

1. M. Hilty, ―Ubiquitous Computing in the Workplace: What Ethical Issues?‖ no. August, pp. 1–16, 2014, [Online].http://link.springer.com/bookseries/11156L.
2. https://web.uettaxila.edu.pk/CMS/SP2014/teMPCms/tutorial%5CFundamentalsOfMobilePervasiveComputing.pdf
3. http://pervasivecomputing.se/M7012E_2014/material/Wiley.Ubiquitous.Computing.Smart.Devices.Environments.And.Interactions.May.2009.eBook.pdf
4. http://media.techtarget.com/searchMobileComputing/downloads/Mobile_and_pervasive_computing_Ch06.pdf

MOOC Courses Links:

https://www.georgiancollege.ca/academics/part-time-studies/courses/mobile-and-pervasive-computing-comp-3025/

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410244(B): Multimedia Techniques

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

Prerequisite Courses: Computer Graphics (210241)

Companion Course: Laboratory Practice IV(410247)

Course Objectives:

- To understand input and output devices, device drivers, control signals and protocols, DSPs
- To study and use standards (e.g., audio, graphics, video)
- To implement applications, media editors, authoring systems, and authoring by studying streams/structures, capture/represent/transform, spaces/domains, compression/coding
- To design and develop content-based analysis, indexing, and retrieval of audio, images, animation, andvideo
- 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 andsystems.

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 data type, Image data type:8 bit & 24-bit color images, Higher bit depth images, Color Lookup tables. File Formats: GIF, JPEG, PNG, TIFF, PSD, APS, AI, INDD, RAW, Windows BMP, Windows WMF,

Netpbm format, EXIF, PTM, Text file format: RTF, TGA Applications/Use of text in Multimedia	
#Exemplar/CaseStudies	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), Digital Video: Chroma Subsampling, High-Definition TV, Ultra High Definition TV (UHDTV), Component Video: High-Definition Multimedia Interface (HDMI),3D Video and TV: various cues, Basics of Digital Audio: What is Sound?, Nyquist Theorem, SNR, SQNR, Audio Filtering, Synthetic Sounds, MIDI Overview: Hardware, Structure, Conversion to WAV, Coding of Audio: PCM, DPCM, DM (Delta Modulation)

#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 of compression algorithms-lossless compression algorithms RLC, VLC, DBC, AC, lossless image compression, differential coding of Images, lossy compression algorithms-Rate distortion theory, Quantization ,Transform coding, wavelet based coding, embedded Zerotress of wavelet coefficients . Image compression standard -JPEG standard, JPEG 2000 standard, LS standard, Bilevel image compression standard. Introduction to video compression - video compression based on motion compensation, Search for motion vectors, MPEG Video coding I , MPEG 1,2,4,7 onwards. Basic Audio Compression Techniques -ADPCM in speech coding, Vocoders, MPEG audio compression

#Exemplar/Case Studies	Implementation of compression algorithms
***Mapping of Course Outcomes for Unit IV**	CO3, 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 foundations for Immersive Experiences. Input devices – controllers, motion trackers and motion capture technologies for tracking, navigation and gestural control. Output devices – Head Mounted VR Displays, Augmented and Mixed reality glasses. 3D interactive and procedural graphics. Immersive surround sound. Haptic and vibrotactile devices. Best practices in VR, AR and MR Future applications of Immersive Technologies.

VRML Programming Modeling objects and virtual environments Domain Dependent applications: Medical, Visualization, Entertainment, etc.

#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 :

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

MOOC Courses Links:

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

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410244(C): Cyber Security and Digital Forensics

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

Prerequisite Courses: Computer Networks and Security(310244), Information Security(310254(A))

Companion Course: 410246: Laboratory Practice IV

Course Objectives:

- To enhance awareness cyber forensics.
- To understand issues in cyber crime and different attacks
- To understand underlying principles and many of the techniques associated with the digital forensic practices
- To know the process and methods of evidence collection
- To analyze and validate forensic data collected.
- To apply digital forensic knowledge to use computer forensic tools and investigation report writing.

Course Outcomes: At the end of the course, the student should be able to:

CO1: Analyze threats in order to protect or defend it in cyberspace from cyber-attacks.
CO2: Build appropriate security solutions against cyber-attacks.
CO3:Underline the need of digital forensic and role of digital evidences.
CO4: Explain rules and types of evidence collection
CO5: Analyze, validate and process crime scenes
CO6: Identify the methods to generate legal evidence and supporting investigation reports.

Course Contents

Unit 1	Introduction to Cyber Security	06 Hours

Introduction and Overview of Cyber Crime, Nature and Scope of Cyber Crime, Types of Cyber Crime: crime against an individual, Crime against property, Cyber extortion, Drug trafficking, cyber terrorism. Need for Information security, Threats to Information Systems, Information Assurance, Cyber Security, and Security Risk Analysis.

#Exemplar/Case Studies	Data Breach Digest – Perspective & Reality : http://verizonenterprise.com/databreachdigest
***Mapping of Course Outcome for Unit I**	CO1

Unit 2	Cyber Crime Issues and Cyber attacks	06 Hours

Unauthorized Access to Computers, Computer Intrusions, Viruses, and Malicious Code, Internet Hacking and Cracking, Virus and worms, Software Piracy, Intellectual Property, Mail Bombs, Exploitation, Stalking and Obscenity in Internet, Cybercrime prevention methods, Application security (Database, E-mail, and Internet), Data Security Considerations-Backups, Archival Storage and Disposal of Data, Security Technology-Firewall and VPNs, Hardware protection mechanisms, OS Security

#Exemplar/Case Studies	Cyber Stalking types & their cases respectively
***Mapping of Course Outcome for Unit II**	CO2

Unit 3	Introduction to Digital Forensics	06 Hours

What is Computer Forensics?, Use of Computer Forensics in Law Enforcement, Computer Forensics Assistance to Human Resources/Employment Proceedings, Computer Forensics Services, Benefits of Professional Forensics Methodology, Steps taken by Computer Forensics Specialists Types of Computer

Forensics Technology: Types of Military Computer Forensic Technology, Types of Law Enforcement — Computer Forensic Technology, Types of Business Computer Forensic Technology Computer Forensics Evidence and Capture: Data Recovery Defined, Data Back-up and Recovery, The Role of Back-up in Data Recovery, The Data-Recovery Solution.

#Exemplar/Case Studies	Demonstrate practice Linux networking security recovery commands.& Study Tools viz; FTK & The Sleuth Kit
***Mapping of Course Outcome for Unit III**	CO3

Unit 4	**Evidence Collection and Data Seizure**	**06 Hours**

Why Collect Evidence? Collection Options ,Obstacles, Types of Evidence — The Rules of Evidence, Volatile Evidence, General Procedure, Collection and Archiving, Methods of Collection, Artifacts, Collection Steps, Controlling Contamination: The Chain of Custody Duplication and Preservation of Digital Evidence: Preserving the Digital Crime Scene — Computer Evidence Processing Steps, Legal Aspects of Collecting and Preserving Computer Forensic Evidence Computer Image Verification and Authentication: Special Needs of Evidential Authentication, Practical Consideration, Practical Implementation.

#Exemplar/Case Studies	Understand how computer forensics works by visiting: http://computer.howstuffworks.com/computer-forensic.htm/printable(23 December 2010)
***Mapping of Course Outcome for Unit IV**	CO4

Unit 5	**Computer Forensics analysis and validation**	**06 Hours**

Determining what data to collect and analyze, validating forensic data, addressing data-hiding techniques, and performing remote acquisitions Network Forensics: Network forensics overview, performing live acquisitions, developing standard procedures for network forensics, using network tools, examining the honeynet project. Processing Crime and Incident Scenes: Identifying digital evidence, collecting evidence in private-sector incident scenes, processing law enforcement crime scenes, preparing for a search, securing a computer incident or crime scene, seizing digital evidence at the scene, storing digital evidence, obtaining a digital hash, reviewing a case

#Exemplar/Case Studies	Discuss cases under Financial Frauds, Matrimonial Frauds, Job Frauds, Spoofing, and Social media. Then write down safety tips, precautionary measures for the discussed fraud cases.
***Mapping of Course Outcomes for Unit V**	CO5

Unit 6	**Current Computer Forensic tools**	**06 Hours**

Evaluating computer forensic tool needs, computer forensics software tools, computer forensics hardware tools, validating and testing forensics software E-Mail Investigations: Exploring the role of e-mail in investigation, exploring the roles of the client and server in e-mail, investigating e-mail crimes and violations, understanding e-mail servers, using specialized e-mail forensic tools.

#Exemplar/Case Studies	Install Kali Linux & practice following examples: 1. https://www.youtube.com/watch?time_continue=6&v=MZXZctqIU-w&feature=emb_logo
***Mapping of Course Outcome for Unit VI**	CO6

Learning Resources

Text Books:

1. John R. Vacca, "Computer Forensics", Computer Crime Investigation Firewall Media, New Delhi.
2. Nelson, Phillips Enfinger, Steuart, "Computer Forensics and Investigations", CENGAGE Learning

Reference Books:

1. Keith J. Jones, Richard Bejtiich, Curtis W. Rose, "Real Digital Forensics", Addison-

Wesley Pearson Education

2. Tony Sammes and Brian Jenkinson, "Forensic Compiling", A Tractitioneris Guide, Springer International edition.

3. Christopher L.T. Brown, "Computer Evidence Collection & Presentation", Firewall Media.

4. Jesus Mena, "Homeland Security, Techniques & Technologies", Firewall Media.

e books:

1. **https://www.pdfdrive.com/computer-forensics-investigating-network-intrusions-and-cyber-crime-e15858265.html**
2. **https://dokumen.pub/handbook-of-computer-crime-investigation-forensic-tools-and-technology-1stnbsped-0121631036-9780121631031.html**
3. **Massachusetts Institute of Technology Open Courseware: https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-858-computer-systems-security-fall-2014/**

MOOC Courses Links:

- **MIT Open CourseWare: https://ocw.mit.edu/courses/**

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410244(D): Object Oriented Modeling and Design

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

Prerequisite Courses: Software Engineering (210245)

Companion Course: Laboratory Practice IV (410247)

Course Objectives:

- Describe the concepts involved in Object-Oriented modelling and their benefits.
- Demonstrate concept of use-case model, sequence model and state chart model for a given problem.
- Explain the facets of the unified process approach to design and build a Software system.
- Translate the requirements into implementation for Object Oriented design.
- Choose an appropriate design pattern to facilitate development procedure. Select suitable design pattern depending on nature of application.
- To describe Designing and Management of Patterns.

Course Outcomes:

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

CO1: Describe the concepts of object-oriented and basic class modelling.
CO2: Draw class diagrams, sequence diagrams and interaction diagrams to solve problems.
CO3: Choose and apply a befitting design pattern for the given problem
CO4: To Analyze applications, architectural Styles & software control strategies
CO5: To develop Class design Models & choose Legacy Systems.
CO6:To Understand Design Patterns

Course Contents

Unit I	Introduction To Modeling	06 Hours

What is Object Orientation? What is OO development? OO themes; Evidence for usefulness of OO development; OO modeling history Modeling as Design Technique: Modeling; abstraction; The three models. Class Modeling: Object and class concepts; Link and associations concepts; Generalization and inheritance; A sample class model; Navigation of class models; Practical tips.

#Exemplar/Case Studies	Case Study of ATM System
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Advanced Class Modeling and State Modeling	06 Hours

Advanced object and class concepts; Association ends; N-ary associations; Aggregation; Abstract classes; Multiple inheritance; Metadata; Reification; Constraints; Derived data; Packages; Practical tips. State Modeling: Events, States, Transitions and Conditions; State diagrams; State diagram behavior; Practical tips.

#Exemplar/CaseStudies	Case Study of Train Reservation System
***Mapping of Course Outcomes for Unit II**	CO2

Unit III	**Advanced State Modeling and Interaction Modeling**	**06 Hours**

Advanced State Modeling: Nested state diagrams; Nested states; Signal generalization; Concurrency; A sample state model; Relation of class and state models; Practical tips.Interaction Modeling: Use case models; Sequence models; Activity models. Use case relationships; Procedural sequence models; Special constructs for activity models.

#Exemplar/Case Studies	Case Study of Coffee Vending Machine
***Mapping of Course Outcomes for Unit III**	CO2, C03

Unit IV	**User Application Analysis : System Design**	**06 Hours**

Application Analysis: Application interaction model; Application class model; Application state model; Adding operations. Overview of system design; Estimating performance; Making a reuse plan; Breaking asystem in to sub-systems; Identifying concurrency; Allocation of sub-systems; Management of datastorage; Handling global resources;
Choosing a software control strategy; Handling boundary conditions; Setting the trade-off priorities; Common architectural styles; Architecture of the ATM system as the example

#Exemplar/Case Studies	Case System of ATM System
***Mapping of Course Outcomes for Unit IV**	CO3, CO4

Unit V	**Class Design ,Implementation Modeling, Legacy Systems**	**06 Hours**

Class Design: Overview of class design; Bridging the gap; Realizing use cases; Designing algorithms; Recursing downwards, Refactoring; Design optimization; Reification of behavior; Adjustment of inheritance; Organizing a class design; ATM example. Implementation Modeling: Overview of implementation; Fine-tuning classes; Fine-tuning generalizations; Realizing associations; Testing. Legacy Systems: Reverse engineering; Building the class models; Building the interaction model; Building the state model; Reverse engineering tips; Wrapping; Maintenance

#Exemplar/Case Studies	Case study of College Library System
***Mapping of Course Outcomes for Unit V**	CO4, CO5

Unit VI	**Design Pattern**	**06 Hours**

What is a pattern and what makes a pattern? Pattern categories; Relationships between patterns; Patterndescription Communication Patterns: Forwarder-Receiver; Client-Dispatcher-Server; Publisher-Subscriber.
Management Patterns: Command processor; View handler. Idioms: Introduction; what can idioms provide? Idiomsand style; Where to find idioms; Counted Pointer example

#Exemplar/Case Studies	Design Pattern for Any suitable System
***Mapping of Course Outcomes for Unit VI**	CO6

Learning Resources

Text Books:

1. Michael Blaha, James Rumbaugh, "Object-Oriented Modeling and Design with UML", 2 nd Edition, Pearson Education, 2005.
2. Frank Buchmann, Regine Meunier, Hans Rohnert, Peter Sommer lad, Michael Stal, "Pattern-Oriented Software Architecture, A System of Patterns", Volume 1, John Wiley and Sons, 2007

Reference Books:

1. Grady Booch et al, "Object-Oriented Analysis and Design with Applications", 3rd Edition, Pearson Education, 2007
2. Brahma Dathan, Sarnath Ramnath, "Object-Oriented Analysis, Design, and Implementation", UniversitiesPress, 2009
3. Hans-Erik Eriksson, Magnus Penker, Brian Lyons, David Fado, " UML 2 Toolkit", Wiley-Dreamtech India, 2004
4. Simon Bennett, Steve McRobb and Ray Farmer, " UML 2 Toolkit, Object- Oriented Systems Analysis and Design Using UML, 2 nd Edition, Tata McGraw-Hill, 2002

e-Books :

1. Object Oriented Modeling and Design - https://www.pdfdrive.com/object-oriented-design-and-modeling-d10014860.html
2. https://www.gopalancolleges.com/gcem/course-material/computer-science/course-plan/sem-Vll/object-oriented-modeling-and-design-10CS71.pdf

MOOC Lectures Links:

- https://nptel.ac.in/courses/106105153

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410244(E): Social Network Analysis and Mining

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

Prerequisite Courses: Machine Learning, Deep Learning

Companion Course: Laboratory Practice IV(410247)

Course Objectives:

- Understand the foundations, terminology, and evolution of Social Network Analysis (SNA).
- Learn graph-theoretical concepts used in modeling and analyzing networks.
- Explore network measures and generative models for analyzing growth and structure.
- Apply techniques for extracting, analyzing, and modeling web and social media data.
- Use mining and visualization approaches to gain insights from large-scale network data.

Course Outcomes:

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

CO1: Explain the key concepts and features of SNA.
CO2: Apply graph-theory-based measures for analyzing network structure and behavior.
CO3: Use network growth models to simulate and interpret network evolution.
CO4: Perform extraction, modeling, and analysis of online social network data.
CO5: Implement mining techniques on Twitter, Facebook, LinkedIn, GitHub, web pages, and email corpora.
CO6: Visualize complex networks using various layouts and interpret the results for real-world applications

Course Contents

Unit I	INTRODUCTION	08 Hours

Social Network Analysis: Definition and Features – The Development of Social Network Analysis – Basic Graph Theoretical Concepts of Social Network Analysis – Ties, Density, Path, Length, Distance, Betweenness, Centrality, Clique – Electronic Sources for Network Analysis – Electronic Discussion Networks, Blogs and Online Communities, Web-based Networks – Applications of Social Network Analysis.

#Exemplar/Case Studies	Study how LinkedIn models connections as a graph — nodes as users, edges as connections. Measure degree centrality to rank influential professionals in a field.
*Mapping of Course Outcomes for Unit I	CO1

Unit II	SOCIAL NETWORK ANALYSIS	08 Hours

Introduction to Social Networks Profiles – Types of Commercial Social Network Profiles (CSNP) – Quantitative and Qualitative Analysis of CSNP – Analysis of Social Networks Extracted from Log Files – Data Mining Methods Related to SNA and Log Mining – Clustering Techniques – Case Study.

#Exemplar/Case Studies	How Facebook exposed and later restricted its Social Graph API; demonstrates CSNP structure, edge types (friends, likes, groups), and privacy implications of profile-level mining.
***Mapping of Course Outcomes for Unit II**	CO1

Unit III	**NETWORK MEASURES AND GROWTH MODELS**	**08 Hours**

Network basics, local node-level measures, Node centrality, Assortativity, Transitivity, Reciprocity, Similarity, Degeneracy, Random network model, ring lattice network model, Watts-Strogatz model, preferential attachment model, Price's model, local-world network model, network model with accelerating growth, Link analysis, community structure in networks

#Exemplar/Case Studies	Google's PageRank is a direct application of link analysis and eigenvector centrality; a webpage's importance depends on the quality and quantity of pages linking to it.
***Mapping of Course Outcomes for Unit III**	CO2

Unit IV	**EXTRACTING AND ANALYZING WEB SOCIAL NETWORKS**	**08 Hours**

Group-level measures, subgroups and community detection, inferential statistics for complete networks, exponential random graph models, directed networks, stochastic actor-oriented models, Link prediction, Social Tie analysis and Social Influence Analysis, User behaviour Modeling and Prediction, community analysis.

#Exemplar/Case Studies	Social influence analysis on Twitter showed super-spreader accounts (< 0.1% of users) were responsible for >70% of misinformation diffusion — demonstrating influence concentration.
***Mapping of Course Outcomes for Unit IV**	CO3

Unit V	**MINING THE SOCIAL WEB**	**08 Hours**

Mining Twitter – examining tweets and their patterns, Mining Facebook – analyzing social graph connections, Mining LinkedIn – exploring LinkedIn API, Mining Web pages – scraping, parsing and crawling the web, Mining Git Hub – property graphs and interest graphs, Mining mail boxes – getting and analyzing Enron corpus.

#Exemplar/Case Studies	GitHub's contribution graph (green squares) is itself a mined social artifact; researchers use the GitHub API to build developer interest graphs and recommend collaborators.
***Mapping of Course Outcomes for Unit V**	CO5

Unit VI	**VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS**	**08 Hours**

Visualization of Social Networks Node-Edge Diagrams – Random Layout – Force-Directed Layout – Tree Layout – Matrix Representations –Matrix and Node-Link Diagrams – Hybrid Representations – Visualizing Online Social Networks – Applications – Covert Networks – Community Welfare – Collaboration Networks – Co-Citation Networks – Data Privacy in Social Networks

#Exemplar/Case Studies	Researchers used Gephi's ForceAtlas2 layout on the DBLP co-authorship graph to visually identify research sub-communities; clusters emerged naturally from the physics-based simulation.

*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. Hansen, Shneiderman & Smith – *Analyzing Social Media Networks with NodeXL*
2. Easley & Kleinberg – *Networks, Crowds and Markets*
3. Newman – *Networks: An Introduction*

Reference Books:

1. Wasserman & Faust – *Social Network Analysis: Methods and Applications*
2. Matthew Russell – *Mining the Social Web*
3. Barabási – *Network Science*

e-Books : https://onlinelibrary.wiley.com/doi/chapter-epub/10.1002/9781119836759.fmatter, https://dokumen.pub/qdownload/social-network-analysis-9781506389325-1506389325.html

MOOC Courses Links:

- **Social Network Analysis and Mining:** https://onlinecourses.nptel.ac.in/noc26_cs82/preview

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
Elective IV
410245(A): Information Retrieval

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

Prerequisite Courses: Database Management Systems(310241)

Companion Course: Laboratory Practice IV(410247)

Course Objectives:

- To study basic concepts of Information Retrieval.
- To study concepts of Indexing for Information Retrieval.
- To analyze the performance of information retrieval using advanced techniques such as classification, clustering, and filtering over multimedia.
- To provide comprehensive details about various Evaluation methods.
- To understand the changes necessary to transfer a Basic IR system into large scale search service system.
- To understand Parallel Information retrieval and Web structures .

Course Outcomes:

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

CO1: Implement the concept of Information Retrieval
CO2: Generate quality information out of retrieved information
CO3: Apply techniques such as classification, clustering, and filtering over multimedia to analyzethe information
CO4: Evaluate and analyze retrieved information
CO5: Understand the data in various Application and Extensions of information retrieval
CO6: Understand Parallel information retrieving and web structure.

Course Contents

Unit I	Introduction , Basic techniques, &Token	07 Hours

Introduction: The IR System, The Software Architecture Of The IR System, **Basic IR Models:** Boolean Model, TF-IDF (Term Frequency/Inverse Document Frequency) Weighting, Vector Model, Probabilistic Model and Latent Semantic Indexing Model. **Basic Tokenizing:** Simple Tokenizing, Stop-Word Removal and Stemming.

#Exemplar/Case Studies	A Case Study Of Onitsha Divisional Library Which Aims At Finding TheCauses And Solutions To The Problems Of Information Retrieval Methods By The Library.
*Mapping of Course Outcomes for Unit I	CO 1

Unit II	Static Inverted Indices and Query Processing	07 Hours

Static Inverted Indices :Inverted Index Construction, **Index Components and Index Life Cycle, The Dictionary** : Sort-based dictionary ,Hash-based dictionary, Interleaving Dictionary and Postings Lists, **Index Construction:** Different types of Index Construction, In-Memory Index Construction, Sort-Based Index Construction, Merge-Based Index Construction, Disk-Based Index Construction), **Other types of Indices**. **Query Processing : Query Processing for Ranked Retrieval** , Document-at-a-Time QueryProcessing, Term-at-a-Time Query Processing, Pre-computing Score Contributions, Impact Ordering),**Query optimization, Lightweight Structure :** Generalized Concordance Lists, Operators, Implementation & Examples

#Exemplar/CaseStudies	Match the search statement with the stored database
***Mapping of Course Outcomes for Unit II**	CO2

Unit III	Index Compression and Dynamic Inverted Indices	07 Hours

General-Purpose Data Compression, **Data Compression :** Modeling and Coding, Huffman Coding, Arithmetic Coding, Symbolwise Text Compression, **Compressing Postings Lists:** Nonparametric Gap Compression, Parametric Gap Compression, Context-Aware Compression Methods, Index Compression for High Query Performance, Compression Effectiveness, DecodingPerformance, Document Reordering. **Dynamic Inverted Indices:** Incremental Index Updates, Contiguous Inverted Lists, Noncontiguous Inverted, **Document Deletions:** Invalidation List, Garbage Collection, Document Modifications,

#Exemplar/Case Studies	Translating Short Segments with NMT: A Case Study in English-to-Hindi
***Mapping of Course Outcomes for Unit III**	CO2

Unit IV	Probabilistic Retrieval and Language Modeling & Related Methods , Categorization & Filtering	07 Hours

Probabilistic Retrieval: Mdeling Relevance, The Binary Independence Model, Term Frequency, Document Length:BM25, Relevance Feedback, Field Weights, **Language Modeling and Related Methods:** Generating Queries from Documents, Language Models and Smoothing, Ranking with Language Models, Divergence from Randomness, PassageRetrieval and Ranking **Categorization and Filtering:** Detailed Examples, Classification, Linear, Similarity- Based, Probabilistic Classifiers, Generalized Linear Models. Information-Theoretic Model. E-Mail on the Move: Categorization, Filtering, and Alerting on Mobile Devices with the if Mail Prototype

#Exemplar/Case Studies	E-Mail on the Move: Study of E-mail Categorization, Filtering, and Alerting on Mobile Devices

*Mapping of Course Outcomes for Unit IV	CO3

Unit V	Measuring Effectiveness and Measuring Efficiency	07 Hours

Measuring Effectiveness - Traditional effectiveness measure, The Text Retrieval Conference (TREC), Using statistics in evaluation, Minimizing adjudication Effort, Nontraditional effectiveness measures, **Measuring Efficiency –** Efficiency criteria, Query Scheduling, Caching, Introduction to Redisand Memcached

#Exemplar/Case Studies	Study of API Handling
*Mapping of Course Outcomes for Unit V	CO 4

Unit VI	Parallel Information retrieval , Web Search	07 Hours

Parallel Information retrieval - Parallel Query Processing, MapReduce, **Web Search-** The structure of the web, Quires and Users, Static ranking, Dynamic ranking, Evaluation web search, Web Crawlers, Web crawler libraries, Python Scrapy, BeautifulSoup

#Exemplar/Case Studies	Study of Google Map / Facebook information retrieval
*Mapping of Course Outcomes for Unit VI	**CO 5 , CO6**

Learning Resources

Text Books:

1. S. Buttcher, C. Clarke and G. Cormack, "Information Retrieval: Implementing and Evaluating Search Engines" MIT Press, 2010, ISBN: 0-408-70929-4.
2. C. Manning, P. Raghavan, and H. Schütze, "Introduction to Information Retrieval", Cambridge University Press, 2008, -13: 9780521865715
3. Ricardo Baeza , Yates and Berthier Ribeiro Neto, "Modern Information Retrieval: The Concepts and Technology behind Search", 2nd Edition, ACM Press Books 2011.
4. Bruce Croft, Donald Metzler and Trevor Strohman, "Search Engines: Information Retrieval in Practice", 1st Edition Addison Wesley, 2009, ISBN: 9780135756324

Reference Books:

1. C.J. Rijsbergen, "Information Retrieval", (http://www.dcs.gla.ac.uk/Keith/Preface.html)
2. W.R. Hersh, "Information Retrieval: A Health and Biomedical Perspective", Springer, 2002.
3. G. Kowalski, M.T. Maybury. "Information storage and Retrieval System" , Springer, 2005
4. W.B. Croft, J. Lafferty, "Language Modeling for Information Retrieval", Springer, 2003

e-Books :

1. Information Retrieval- www.informationretrieval.org

MOOC Courses Links:

- https://nptel.ac.in/courses/117102060

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
Elective IV
410245(B): GPU Programming and Architecture

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

Prerequisites Courses: Computer Graphics(210244)

Companion Course: Laboratory Practice IV(410247)

Course Objectives:

- To Understand Graphics Processing Unit (GPU) Concepts.
- To understand the basics of GPU architectures
- To write programs for massively parallel processors
- To understand the issues in mapping algorithms for GPUs
- To introduce different GPU programming models
- To examine the architecture and capabilities of modern GPUs.

Course Outcomes:

After completion of the course, students should be able to-

CO1: Describe GPU architecture

CO2: Write programs using CUDA, identify issues and debug them.

CO3: Implement efficient algorithms in GPUs for common application kernels, such as matrix multiplication

CO4: Write simple programs using OpenCL

CO5: Identify efficient parallel programming patterns to solve problems

CO6: Explore the modern GPUs architecture and it's Applications.

Course Contents

Unit I	Introduction to Graphics Processing Unit (GPU)	07 Hours

Evolution of GPU architectures – Understanding Parallelism with GPU –Typical GPU Architecture – CUDA Hardware Overview – Threads, Blocks, Grids, Warps, Scheduling – Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory.

#Exemplar/Case Studies	Review of traditional Computer Architecture
*Mapping of Course Outcomes for Unit I	CO 1

Unit II	Cuda Programming	07 Hours

Using CUDA – Multi GPU – Multi GPU Solutions – Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions.

#Exemplar/Case Studies	Write basic CUDA programs.
*Mapping of Course Outcomes for Unit II	CO 2

Unit III	Programming Issues	07 Hours

Common Problems: CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors.		
#Exemplar/Case Studies	Study of various CUDA errors	
***Mapping of Course Outcomes for Unit III**	CO 3	
Unit IV	**Opencl Basics**	**07 Hours**
OpenCL Standard, Kernels, Host Device Interaction, Execution Environment, Memory Model, Basic OpenCL Examples.		
#Exemplar/Case Studies	Write OpenCL basic program	
***Mapping of Course Outcomes for Unit IV**	CO 4	
Unit V	**Algorithms on GPU**	**07 Hours**
Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix – Matrix Multiplication – Programming Heterogeneous Cluster		
#Exemplar/Case Studies	Describe multi-dimensional mapping of dataspace.	
***Mapping of Course Outcomes for Unit V**	CO 5	
Unit VI	**OpenCL and Application Design**	**07 Hours**
OpenCL for Heterogeneous Computing, Application Design : Efficient Neural Network Training/Inferencing		
#Exemplar/Case Studies	Describe OpenCL for Heterogeneous computing	
***Mapping of Course Outcomes for Unit VI**	CO6	

Learning Resources

Text Books:

1. Shane Cook, "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing)", First Edition, Morgan Kaufmann, 2012.
2. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, "Heterogeneous computing with OpenCL", 3rd Edition, Morgan Kauffman, 2015.
3. Benedict Gaster,Lee Howes, David R. Kaeli, "Heterogeneous Computing with OpenCL"

Reference Books :

1. Nicholas Wilt, "CUDA Handbook: A Comprehensive Guide to GPU Programming", Addison –Wesley, 2013.
2. Jason Sanders, Edward Kandrot, "CUDA by Example: An Introduction to General Purpose GPUProgramming", Addison – Wesley, 2010.
3. David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors ", A Hands-onApproach, Third Edition, Morgan Kaufmann, 2016.
4. http://www.nvidia.com/object/cuda_home_new.html
5. http://www.openCL.org

e-Books :

1. https://www.perlego.com/book/1418742/cuda-handbook-a-comprehensive-guide-to- gpu-programming-the-pdf

NPTEL/YouTube video lecture link

- https://onlinecourses.nptel.ac.in/noc20_cs41/preview

@The CO-PO Mapping Matrix

CO/ PO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO1 1	PO1 2
CO1	1	2	1	1	2	-	1	-	-	-	-	-
CO2	1	2	2	2	2	-	-	-	-	-	-	-
CO3	1	2	2	2	2	-	-	-	-	-	-	-
CO4	1	2	2	2	2	-	-	-	-	-	-	-
CO5	1	2	2	2	2	-	-	-	-	-	-	-
CO6	1	2	2	1	2	-	-	-	-	-	-	-

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
Elective IV
410245(C): Mobile Computing

Teaching Scheme:	Credit	Examination Scheme:100
TH: 3 Hours/Week	3	Mid-Semester (TH) : 30 End- Sem (TH): 70

Prerequisites Courses: Computer Networks and Security(310244)

Companion Course: Laboratory Practice IV(410247)

Course Objectives:

- To introduce the basic concepts and principles in mobile computing. This includes major techniques involved, and networks & systems issues for the design and implementation of mobile computing systems and applications
- To demonstrate the protocols of mobile communication.
- To know GSM architecture and support services
- To Study on location, handoff management and wireless fundamentals.
- To summarize VLR and HLR identification algorithms
- To learn current technologies being used on field and design and development of various network protocol using simulation tools.

Course Outcomes:

CO1: Develop a strong grounding in the fundamentals of mobile Networks
CO2: Apply knowledge in MAC, Network, and Transport Layer protocols of Wireless Network
CO3: Illustrate Global System for Mobile Communications
CO4: Use the 3G/4G technology based network with bandwidth capacity planning,VLR and HLR identification algorithms
CO5: Classify network and transport layer of mobile communication
CO6: Design & development of various wireless network protocols using simulationtools

Course Contents

Unit I	Introduction to Mobile Computing	07 Hours

Introduction to Mobile computing, Constraints in mobile computing, Application of mobile computing, Generations of mobile wireless 1G to 5G, Future of mobile computing, Radio frequency Technology, Public Switched Telephone network, (PSTN), Public Communication service (PCS), PCS Architecture, , Blue tooth, Ad-hoc Networks.

#Exemplar/Case Studies	5G Network , Spectrum sharing for D2D communication in 5G cellular networks
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Mobile Wireless protocols	07 Hours

Introduction of WAP, WAP applications, WAP Architecture, WAP Protocol Stack, Challenges in WAP . Introduction, Benefits, Difference, Routing protocols for ad hoc wireless networks: DSDV and AODV,

Wireless Application protocols: MAC,SDMA, FDMA,TDMA,CDMA, Cellular Wireless Networks. Wireless Communication: Cellular systems, Frequency Management and Channel Assignment Types of handoff

and their characteristics.		
#Exemplar/Case Studies	IPoC: A New Core Networking Protocol for 5G Networks.	
***Mapping of Course Outcomes for Unit II**	CO2	
Unit III	**Global System for Mobile Communicatio**	**07 Hours**
Global System for Mobile Communications (GSM) architecture , Mobile Station, Base Station System, Switching subsystem, Security, Data Services, HSCSD, GPRS - GPRS system and protocol architecture 2.3 UTRAN, UMTS core network; Improvements on Core Network, 802.11 Architecture 802.11a, 802.11b standard		
#Exemplar/Case Studies	5G mobile communications	
***Mapping of Course Outcomes for Unit III**	CO3	
Unit IV	**GSM Networking Signaling and Mobile Management**	**07 Hours**
GSM MAP Service framework, MAP protocol machine, GSM location management, Transaction management, Mobile database, Introduction to location management HLR andLR VLR and HLR Failure restoration, VLR identification algorithm, O-I, O-II algorithm etc. Overview of handoff process; Factors affecting handoffs and performance evaluation metrics; Handoff strategies; Different types of handoffs (soft, hard, horizontal, vertical).		
#Exemplar/Case Studies	5G Mobility Management , Micro Mobility: CellularIP, HAWAII, HMIPv6	
***Mapping of Course Outcomes for Unit IV**	CO4	
Unit V	**Mobile Network and Transport Layers**	**07 Hours**
Mobile IP , IP packet delivery, Tunnelling and encapsulation, IPv6, DHCP, Vehicular Ad Hoc networks (VANET), MANET , Traditional TCP, Snooping TCP, Mobile TCP, 3G wireless network, Wireless Application Protocol, WDP WTP, WML, WTA architecture, Cellular IP		
#Exemplar/Case Studies	5G Network and Transport Layers	
***Mapping of Course Outcomes for Unit V**	CO5	
Unit VI	**Wireless Application Protocol (WAP) and current trends**	**07 Hours**
WAP model, WAP Gateway, WAP protocol, WAP UAProf and Caching, Wireless Bearer for WAP, WAP Developer Toolkits, Introduction to D2D communications; High level requirements for 5G architecture; Introduction to the radio resource management, power control and mode selection problems; Millimeter wave communication in 5G, Introduction to mobile cloud computing and its Applications		
#Exemplar/Case Studies	Long-Term Evolution (LTE) of 3GPP	

*Mapping of Course Outcomes for Unit VI	CO6

Learning Resources

Text Books:

1. Jochen Schiller, "Mobile Communications", Pearson Education, 2009.
2. Martin Sauter, "3G, 4G and Beyond: Bringing Networks, Devices and the Web Together", 2012, ISBN-13: 978-1118341483
3. Raj Kamal, "Mobile Computing", 2/e, Oxford University Press

Reference Books :

1. William Stallings, ""Wireless Communications & Networks", Second Edition, Pearson Education
2. Christopher Cox, "An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G MobileCommunications", Wiley publications
3. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2012.

e-B ooks :

1. http://www.dauniv.ac.in/downloads/Mobilecomputing/Microsoft%20%20MobileCompChap02L02HandhelCompandMobileOSes.pdf

MOOC Courses Links :

- https://nptel.ac.in/courses/106106147

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
Elective IV
410245 (D): Software Testing and Quality Assurance

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

Prerequisite Courses: Software Engineering (210253), Software Project Management(310245(D))

Companion Course: **Lab Practice IV**

Course Objectives:

- Introduce basic concepts of software testing.
- Understand the best way to increase the effectiveness, test coverage, and execution speed in software testing.
- Understand white box, block box, object oriented, web based and cloud testing.
- Understand the importance of software quality and assurance software systems development.
- Know in details automation testing and tools used for automation testing.
- To learn and understand the combination of practices and tools that are designed to help QA professionals test more efficiently.

Course Outcomes:

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

CO1: Describe fundamental concepts in software testing such as manual testing, automation testing and software quality assurance.
CO2: Design and Develop project test plan, design test cases, test data, and conduct test operations.
CO3: Apply recent automation tool for various software testing for testing software.
CO4: Apply different approaches of quality management, assurance, and quality standard to software system.
CO5: Apply and analyze effectiveness Software Quality Tools.
CO6: Apply tools necessary for efficient testing framework.

Course Contents

Unit I	Introduction to Software Testing	07 Hours

Introduction: historical perspective, Definition, Core Components, Customers suppliers and process, Objectives of Testing, Testing and Debugging, Need of Testing, Quality Assurance and Testing, Why Software has Errors, Defects and Failures and its Causes and Effects, Total Quality Management(TQM), Quality practices of TQM, Quality Management through- Statistical process Control, Cultural Changes, Continual Improvement cycle, Benchmarking and metrics, Problem Solving Techniques and Software Tools. Software Quality, Constraints of Software product Quality assessment, Quality and Productivity Relationship, Requirements of Product, Software Development Process, Types of Products, Software Development Lifecycle Models, Software Quality Management, Processes related to Software Quality, Quality Management System's Structure, Pillars of Quality Management System, Important aspects of quality management.

#Exemplar/Case Studies	1. Offshore delivery model for an Airline Company. 2. SAP test automation CoE for Financial Service Provider.

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

Unit II	**Test Planning and Quality Management**	**07 Hours**

Test Planning –Artifacts & Strategy, Test Organization –Test Manager & Tester Role, Test plan purpose & contents, Test Strategy and Approach, Test cases & Test Data, Test Entry-Exit criteria, Test Execution Schedule, Use case Testing, Scenario Testing, Test Monitoring & Control- Test Metrics –Test Case Productivity, Test case Coverage, Defect Acceptance & Rejection, Test Efficiency, Efforts and Schedule Variance, Test Efforts biasing Factors, Test Report & configuration Management, Quality Assurance Process, Documentation Risk & Issues. Software Quality, Quality Management Importance, Quality Best practices.

#Exemplar/CaseStudies	1. Online Recommendation System 2. Quality Engineering services for Medical Devices company | CaseStudy (cigniti.com)
***Mapping of Course Outcomes for Unit II**	CO2

Unit III	**Test Case Design Techniques**	**07 Hours**

Software Testing Methodologies: White Box Testing, Black Box Testing, Grey Box Testing. Test Case Design Techniques: Static Techniques: Informal Reviews, Walkthroughs, Technical Reviews, Inspection. Dynamic Techniques: Structural Techniques: Statement Coverage Testing, Branch Coverage Testing, Path Coverage Testing, Conditional Coverage Testing, Loop Coverage Testing Black Box Techniques: Boundary Value Analysis, Equivalence Class Partition, State Transition Technique, Cause Effective Graph, Decision Table, Use Case Testing, Experienced Based Techniques: Error guessing, Exploratory testing

Levels of Testing: Functional Testing: Unit Testing, Integration Testing, System Testing, User Acceptance Testing, Sanity/Smoke Testing, Regression Test, Retest. Non-Functional Testing: Performance Testing, Memory Test, Scalability Testing, Compatibility Testing, Security Testing, Cookies Testing, Session Testing, Recovery Testing, Installation Testing, Adhoc Testing, Risk Based Testing, I18N Testing, L1ON Testing, Compliance Testing.

Link:https://www.besanttechnologies.com/training-courses/software-testing-training/manual-testing-training-institute-in-chennai

#Exemplar/Case Studies	1. Case Study: Manual Testing (Online Marketing SoftwarePlatform) Link: https://www.360logica.com/blog/case-study-manual-testing-online-marketing-software-platform/ 2. Case Study: Decision Table Testing (transferring money online to an account which is already added and approved.)
***Mapping of CO**	**CO3**

Unit IV	**Software Quality Assurance and Quality Control**	**07 Hours**

Software Quality Assurance: Introduction, Constraints of Software Product Quality Assessment, Quality and Productivity Relationship, Requirements of a Product, Characteristics of Software,

Software Development Process, Types of Products, Schemes of Criticality Definitions, Software Quality Management, Why Software Has Defects? Processes Related to Software Quality, Quality Management System Structure, Pillars of Quality Management System, Important Aspects ofQualityManagement.

Software Quality Control: Software quality models, Quality measurement and metrics, Quality plan, implementation and documentation, Quality tools including CASE tools, Quality control and reliability of quality process, Quality management system models, Complexity metrics and Customer Satisfaction, International quality standards – ISO, CMM

#Exemplar/Case Studies	1. Case Study #1 – Android Application Acceptance Test Suite 2. Case Study #2 – API Acceptance Test Suite Link for above case studies - Software Quality Assurance Case Studies - Beta Breakers
***Mapping of Course Outcomes for Unit IV**	**CO4**

Unit V	**Automation Testing Tools / Performance Testing Tools**	**07 Hours**

Automation Testing: What is automation testing, Automated Testing Process, Automation Frameworks, Benefits of automation testing, how to choose automation testing tools. Selenium Automation Tools: Selenium's Tool Suite- Selenium IDE, Selenium RC, Selenium Web driver, Selenium Grid. Automation Tools: SoapUI, Robotic Process Automation (RPA), Tosca, Appium.

Performance Testing : What is Performance Testing what is use of it? Tools used for performance testing - Apache Jmeter.

#Exemplar/Case Studies	1. Case Study: Cucumber open-source automation testingframework. 2. Case Study: (PDF) Automated Software Testing—A Case Study(researchgate.net)
***Mapping of Course Outcomes for Unit V**	**CO5**

Unit VI	**Testing Framework**	**07 Hours**

Testing Framework: Software Quality, Software Quality Dilemma, Achieving Software Quality, Software Quality Assurance Elements of SQA, SQA Tasks, Goals and Metrics, Formal Approaches to SQA, Statistical Software Quality Assurance, Six Sigma for Software Engineering, ISO 9000 Quality Standards, SQA Plan, Total Quality Management, Product Quality Metrics, In process Quality Metrics, Software maintenance, Ishikawa's 7 basic tools, Flow Chart, Checklists, Pareto diagrams, Histogram, Run Charts, Scatter diagrams, Control chart, Cause Effect diagram. Defect Removal Effectiveness and Process.

#Exemplar/Case Studies	1. Case study: Software Quality In AcademicCurriculum. 2. Case study: Evaluation of an Automated Testing Framework: ACase Study (scielo.sa.cr)
***Mapping of Course Outcomes for Unit VI**	**CO6**

Learning Resources

Text Books:

1. M G Limaye, "Software Testing Principles, Techniques and Tools", Tata McGraw Hill, ISBN:9780070139909 0070139903
2. Srinivasan Desikan, Gopal Swamy Ramesh, "Software Testing Principles and Practices", Pearson,ISBN-10: 817758121X

Reference Books:

1. Naresh Chauhan, "Software Testing Principles and Practices", OXFORD, ISBN-10: 0198061846. ISBN-13: 9780198061847
2. Stephen Kan, "Metrics and Models in Software Quality Engineering", Pearson, ISBN-10: 0133988082; ISBN-13: 978-0133988086

e-Books :

1. M G Limaye, "Software Testing Principles, Techniques and Tools"
https://books.google.co.in/books?id=zUm8My7SiakC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
2. Srinivasan Desikan, Gopalswamy Ramesh, "Software Testing Principles and Practices"
https://kupdf.net/queue/software-testing-principles-and-practices-by-srinivasan_5b0ae8eae2b6f51f7d862d26_pdf?queue_id=-1&x=1656562364&z=MTE1LjI0Mi4yNDIuNzA=
3. Naresh Chauhan, "Software Testing Principles and Practice"
. https://pdfcoffee.com/download/se-4-pdf-free.html

MOOC Courses Links:

- https://nptel.ac.in/courses/106105150
- NPTEL : NOC: Software Testing (2017) (Computer Science and Engineering) (digimat.in)

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
Elective IV
410252(E): AWS Cloud Application Engineering

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

Prerequisite Courses: Data Structures and Algorithms, Database Management Systems (Relational & NoSQL concepts), Basic Python or JavaScript programming, Fundamentals of Computer Networks and HTTP/REST

Companion Course : Laboratory Practice IV (410247)-

Course Objectives:

- To understand how to program various AWS services using SDK (boto3 / JavaScript SDK).
- To decide the selection of appropriate database services provided by AWS for given use-cases.
- To learn the concept of Infrastructure as Code (IaC) using AWS CloudFormation and Terraform.
- To develop and deploy serverless applications using AWS Lambda and Step Functions.
- To design and manage REST APIs using Amazon API Gateway.
- To implement end-to-end CI/CD pipelines on AWS using CodeCommit, CodeBuild, CodeDeploy, and CodePipeline.

Course Outcomes:

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

CO1: Choose between server-based and serverless services to deploy applications.
CO2: Make use of AWS SDKs to programmatically access and manage AWS services.
CO3: Distinguish between communication protocols and select appropriate.
CO4: Select an appropriate configuration for provisioning infrastructure.
CO5: Develop and deploy a complete web application using various AWS cloud services.
CO6: Design, develop, and deploy a full-stack cloud-native web application on AWS.

Course Contents

Unit I	Programming AWS Services	08 Hours

Contents: IIntroduction to boto3 module for programming in Python Managing EC2 instances, IAM Operations, VPC Components using Python Programming with AWS RDS, AWS DynamoDB, AWS, DocumentDB and AWS Elasticache in Python

#Exemplar/Case Studies	AWS EC2, Amazon S3, Amazon RDS, AWS DynamoDB, AWS IAM
*Mapping of Course Outcomes for Unit	CO1

Unit II	Provisioning Infrastructure Through Code	08 Hours

Cloud Formation concepts, How does Cloud Formation works, , Working with Stacks,Working with Templates, Working with StackSets, Using the Cloud Formation Registry, Logging API, Calls, Infrastructure Security, Configuration and vulnerability analysis, Infrastructure provisioning using Terraform

#Exemplar/Case Studies	Amazon CloudFormation
***Mapping of Course Outcomes for Unit II**	CO2

Unit III	**AWS Serverless**	**08 Hours**

Need for Serverless architecture, How serverless architecture works, Foundations of Lamdba Functions – concepts, features, programming model, architectures, function, scaling, Lambda Permissions – Execution role, resource based policies, user policies, Configuration,Functions, Managing Functions, Invoking Functions, lambda Functions AWS Step Functions, Designing a workflow using AWS Step Functions.

#Exemplar/Case Studies	AWS Lambda, AWS Step Functions
***Mapping of Course Outcomes for Unit III**	CO3

Unit IV	**API Development and Management in AWS**	**08 Hours**

Understanding REST principles, Defining resources and methods, Overview of API Gateway - key features and benefits, creating an API using API Gateway Console,Configuring stages and deployments, Integrating with backend services - Lambda integration, integrating with AWS Services like S3, DynamoDB, API Keys and usage plans, Caching in API Gateway

#Exemplar/Case Studies	Amazon API Gateway
***Mapping of Course Outcomes for Unit IV**	CO4

Unit V	**Building CI/CD Pipelines on AWS**	**07 Hours**

What is CI/CD? CodePipeline concepts, How pipeline execution works, Integration with CodePipeline action types, working with pipelines, working with actions, working with stage transitions, monitoring pipelines, security in pipelines, AWS CodeCommit, AWS CodeBuild, AWS CodeDeploy, Introduction to Jenkins.

#Exemplar/Case Studies	AWS CodeCommit, CodeBuild, CodeDeploy, CodePipeline
***Mapping of Course Outcomes for Unit V**	CO5

Unit VI	**Cloud-Native Application Design and Deployment**	**07 Hours**

Principles of cloud-native application design, Authentication and authorization in cloud applications using Amazon Cognito, Monitoring and observability: AWS CloudWatch metrics, Distributed tracing using AWS X-Ray: service maps, segments, subsegments, Cost optimization strategies: AWS Cost Explorer, Budgets, and right-sizing recommendations, Security best practices: encryption at rest and in transit, End-to-end project: design, develop, and deploy a full-stack cloud-native web application on AWS integrating services.

#Exemplar/Case Studies	Deploy a full-stack cloud-native web application on AWS
***Mapping of Course Outcomes for Unit VI**	CO6

Learning Resources

Text Books:

1. Wittig, Michael, Andreas Wittig, and Ben Whaley. Amazon Web Services in Action. Manning, 2018.
2. Murty, James. Programming Amazon Web Services: S3, EC2, SQS, FPS, and SimpleDB. O'Reilly Media, 2008.
3. Tankariya, Vipul, and Bhavin Parmar. AWS Certified Developer-Associate Guide. Packt Publishing Ltd, 2017.
4. Alteen, Nick, et al. AWS Certified Developer Official Study Guide: Associate (DVA-C01) Exam. Wiley & Sons, 2019.
5. van Vliet, Jurg, Flavia Paganelli, and Jasper Geurtsen. Resilience and Reliability on AWS. O'Reilly Media, 2013.
6. Sarkar, Aurobindo, and Amit Shah. Learning AWS: Design, Build, and Deploy Responsive Applications. Packt Publishing Ltd, 2018.

Reference Books:

1. Kavis, Michael J. Architecting the Cloud: Design Decisions for Cloud Computing Service Models. Wiley & Sons, 2014.
2. Vacca, John R. (Ed.) Cloud Computing Security: Foundations and Challenges. CRC Press, 2016.
3. Furht, Borivoje, and Armando Escalante. Handbook of Cloud Computing, Vol. 3. Springer, 2010.

eBooks:

1. AWS Official Documentation: https://docs.aws.amazon.com/
2. AWS Workshops (hands-on labs): https://www.workshops.aws/
3. Terraform Documentation: https://www.terraform.io/
4. Boto3 SDK Documentation: https://boto3.amazonaws.com/v1/documentation/api/latest/index.ht

MOOC Courses Links:

- **https://nptel.ac.in/courses/106105190**

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science(2019 Course) 410246: Laboratory Practice III

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

Companion Course: Compiler Design (410241), Machine Learning(410242), Blockchain Technology(410243)

Course Objectives:

- Learn effect of data preprocessing on the performance of machine learning algorithms
- Develop in depth understanding for implementation of the regression models.
- Implement and evaluate supervised and unsupervised machine learning algorithms.
- Analyze performance of an algorithm.
- Learn how to implement algorithms that follow algorithm design strategies namely divide and conquer, greedy, dynamic programming, backtracking, branch and bound.
- Understand and explore the working of Blockchain technology and its applications.

Course Outcomes:

After completion of the course, students will be able to

CO1: Apply preprocessing techniques on datasets.
CO2: Implement and evaluate linear regression and random forest regression models.
CO3: Apply and evaluate classification and clustering techniques.
CO4: Analyze performance of an algorithm.
CO5: Implement an algorithm that follows one of the following algorithm design strategies: divide and conquer, greedy, dynamic programming, backtracking, branch and bound.
CO6: Interpret the basic concepts in Blockchain technology and its applications

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal

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

Guidelines for Laboratory /Term Work Assessment

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

Guidelines for Practical Examination

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

Guidelines for Laboratory Conduction

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

Virtual Laboratory:

- http://cse01-iiith.vlabs.ac.in/
- http://vlabs.iitb.ac.in/vlabs-dev/labs/blockchain/labs/index.php
- http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

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

Course Contents

Group A: Compiler Design

Any 4 assignments and 1 mini project are mandatory.

1.	Write a C++/Java program to simulate lexical analyzer for validating operators
2.	Write a C++/Java program to implement LALR parsing.
3.	Write a C++/Java program for constructing of LL (1) parsing.
4.	Create Yacc and Lex specification files to recognizes arithmetic expressions involving +, -, * and /
5.	Write a Lex program to count the number of comment lines in a given C program. Also eliminate them and copy that program into separate file.
6.	To Study about Yet Another Compiler-Compiler(YACC).

7.	**Mini Project** Design a lexical analyzer for given language and the lexical analyzer should ignore redundant spaces, tabs and new lines. It should also ignore comments. Although the syntax specification states that identifiers can be arbitrarily long, you may restrict the length to some reasonable value. Simulate the same in C language OR Implement following programs using Lex. a. Create a Lexer to take input from text file and count no of characters, no. of lines & no. of words. b. Write a Lex program to count number of vowels and consonants in a given input string. OR Implement following programs using Lex. c. Write a Lex program to print out all numbers from the given file. d. Write a Lex program to printout all HTML tags in file. e. Write a Lex program which adds line numbers to the given file and display the same onto the standard output.
Group B: Machine Learning	
Any 4 assignments and 1 Mini project are mandatory.	
1.	Predict the price of the Uber ride from a given pickup point to the agreed drop-off location. Perform following tasks: 1. Pre-process the dataset. 2. Identify outliers. 3. Check the correlation. 4. Implement linear regression and random forest regression models. 5. Evaluate the models and compare their respective scores like R2, RMSE, etc. Dataset link: https://www.kaggle.com/datasets/yasserh/uber-fares-dataset
2.	Classify the email using the binary classification method. Email Spam detection has two states: a) Normal State – Not Spam, b) Abnormal State – Spam. Use K-Nearest Neighbors and Support Vector Machine for classification. Analyze their performance. Dataset link: The emails.csv dataset on the Kaggle https://www.kaggle.com/datasets/balaka18/email-spam-classification-dataset-csv
3.	Given a bank customer, build a neural network-based classifier that can determine whether they will leave or not in the next 6 months. Dataset Description: The case study is from an open-source dataset from Kaggle. The dataset contains 10,000 sample points with 14 distinct features such as CustomerId, CreditScore, Geography, Gender, Age, Tenure, Balance, etc. Link to the Kaggle project: https://www.kaggle.com/barelydedicated/bank-customer-churn-modeling Perform following steps: 1. Read the dataset. 2. Distinguish the feature and target set and divide the data set into training and test sets. 3. Normalize the train and test data. 4. Initialize and build the model. Identify the points of improvement and implement the same. 5. Print the accuracy score and confusion matrix (5 points).

4.	Implement Gradient Descent Algorithm to find the local minima of a function. For example, find the local minima of the function $y=(x+3)^2$ starting from the point x=2.
5.	Implement K-Nearest Neighbors algorithm on diabetes.csv dataset. Compute confusion matrix, accuracy, error rate, precision and recall on the given dataset. Dataset link : https://www.kaggle.com/datasets/abdallamahgoub/diabetes

6.	Implement K-Means clustering/ hierarchical clustering on sales_data_sample.csv dataset. Determine the number of clusters using the elbow method. Dataset link : https://www.kaggle.com/datasets/kyanyoga/sample-sales-data
7.	**Mini Project** Use the following dataset to analyze ups and downs in the market and predict future stock price returns based on Indian Market data from 2000 to 2020. Dataset Link: https://www.kaggle.com/datasets/sagara9595/stock-data OR Build a machine learning model that predicts the type of people who survived the Titanic shipwreck using passenger data (i.e. name, age, gender, socio-economic class, etc.). Dataset Link: https://www.kaggle.com/competitions/titanic/data

Group C: Blockchain Technology	
Any 4 assignments and a Mini project are mandatory.	
1.	Installation of Metamask and study spending Ether per transaction.
2.	Create your own wallet using Metamask for crypto transactions.
3.	Write a smart contract on a test network, for Bank account of a customer for following operations: • Deposit money • Withdraw Money • Show balance
4.	Write a program in solidity to create Student data. Use the following constructs: • Structures • Arrays • Fallback Deploy this as smart contract on Ethereum and Observe the transaction fee and Gas values.
5.	Write a survey report on types of Blockchains and its real time use cases.
6.	**Mini Project:** Create a dApp (de-centralized app) for e-voting system.

@The CO-PO Mapping Matrix

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

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

Savitribai Phule Pune University
Fourth Year of Computer Engineering(2019Course)
410247:Laboratory Practice IV

Teaching Scheme	Credit	Examination Scheme and Marks
Practical:04 Hours/Week	01	Term Work: 50 Marks

Companion Course: Elective III(410244), Elective IV(410245)

Course Objectives:

- Learn android application development related to pervasive computing
- Understand various multimedia file formats
- Understand various vulnerabilities and use of various tools for assessment of vulnerabilities
- Understand information retrieval process using standard tools available
- Learn GPU programming and implementation of same using open source libraries
- Learn installation and use of open source software testing tools

Course Outcomes:

After completion of the course, students will be able to

CO1: Apply android application development for solving real life problems.
CO2: Design and develop system using various multimedia components.
CO3: Identify various vulnerabilities and demonstrate using various tools.
CO4: Apply information retrieval tools for natural language processing
CO5: Develop an application using open source GPU programming languages
CO6: Apply software testing tools to perform automated testing

Guidelines for Instructor's Manual

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

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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.

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

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Virtual Laboratory:

1. https://hci-iitg.vlabs.ac.in/
2. http://vlabs.iitkgp.ernet.in/se/
3. https://vlab.amrita.edu/?sub=3&brch=179&sim=1293&cnt=2

410244(A) Pervasive Computing

Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory.

Group 1

1.	Develop an indoor location system to Library guide system where it can direct a user to the bookshelf from a mobile device.
2.	Design a pervasive application in which remote computer monitors our health statistics & will determine when one is in trouble & will take appropriate action for rescue.
3.	Develop an Android application in which car will use the Internet to find nearby open parking space.
4.	Android User Activity Recognition – Still, Walking, Running, Driving etc.
5.	Design and build a sensing system using micro-controllers like - Arduino / Raspberry Pi / Intel Galileo to sense the environment around them and act accordingly.
6.	Smart Mobile Application with orientation sensing for users to put the phone in meeting / silent mode- OR- outdoor/ loud mode based on the orientation of the device.

Group 2.

7.	**Mini project:** Develop Food Ordering System which uses the GPS of an Android-based Smartphone to record and analyze various locations that could give alert to the user, then asking the user to select particular food from given hotel list and place an order.
8.	**Mini Project :** Design a mobile sensing platform mounted on a glove that integrates several sensors, such as touch pressure, imaging, inertial measurements, localization and a Radio Frequency Identification (RFID) reader for fruit classification and grading system.

9.	**Mini Project :** Sensor-Based Assistive Devices for Visually Impaired People. It should cover following points: o Determining obstacles around the user body from the ground to the head; o Affording some instructions to the user about the movement surface consists of gaps or textures; o Finding items surrounding the obstacles; o Providing information about the distance between the user and the obstacle with essential direction instructions.
10.	**Mini Project:** Develop a Real time application like a smart home with following requirements: If anyone comes at door the camera module automatically captures his image send it to the email account of user or send notification to the user. Door will open only after user's approval.
410244(B) Multimedia Techniques	
Group 1	
Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory.	
1.	To study and install open-source multimedia tools and create an application using appropriate tool to design the college webpage
2.	To create JPEG Image that demonstrate various features of an Image editing tool.
3.	Create or play a sample MIDI format sound file using LMMS / MuseScore / Tuxguitar software tool. Edit the sample file by applying effects like bend, slide, vibrato, and hammer-on/pull-off. Export / Convert final MIDI to WAV file format.
4.	Implement transform coding, quantization, and hierarchical coding for the encoder and decoder of three-level Hierarchical JPEG.
5.	Create an immersive environment (living room/ battlefield/ tennis court) with only static game objects. 3D game objects can be created using Blender or use available 3D models.
6.	Create a web page for a clothing company which contains all the details of that company and atleast five links to other web pages.
Group2	
7.	Mini Project: Design and develop a Navigation Assistance System.
8.	Mini Project: Design and Develop a Traffic Monitoring System.
410244(C) Cyber Security and Digital Forensics	
Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory.	
Group 1	
1.	Write a program for Tracking Emails & Investigating Email Crimes. i.e. Write a program to analyze e–mail header
2.	Implement a program to generate & verify CAPTCHA image
3.	A person on a nearby road is trying to enter into a WiFi network by trying to crack the Password to use the IP Printer resource; write a program detect such attempt and prohibit the

	access. Develop the necessary scenario by Using an IEEE 802.11, configure a Wi-Fi adapter and Access Point
4.	Write a computer forensic application program for Recovering permanent Deleted Files and Deleted Partitions
5.	Write a program for Log Capturing and Event Correlation
6.	Configure and demonstrate use of vulnerability assessment tool like Wireshark or SNORT
7.	Study of Honeypot
Group 2	
1.	Mini–project: Perform the following steps: • Go to the National Child Exploitation Coordination Centre (NCECC) Web site at http:// www.ncecc.ca • Click on the Reporting child exploitation link. • c. Read "How to Report Internet Pornography or Internet Luring Related to Children."
2.	Mini- Project: Perform the following steps: • Go to http://www.usdoj.gov/criminal/cybercrime/cyberstalking.htm. • b. Read the 1999 report on cyber stalking.
410244(D) Object Oriented Modeling and Design	
Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory.	
Group 1	
1.	Draw state model for telephone line, with various activities.
2.	Draw basic class diagrams to identify and describe key concepts like classes, types in your system and their relationships.
3.	Draw one or more Use Case diagrams for capturing and representing requirements of the system. Use case diagrams must include template showing description and steps of the Use Case for various scenarios.
4.	Draw one or more Use Case diagrams for capturing and representing requirements of the system. Use case diagrams must include template showing description and steps of the Use Case for various scenarios.
5.	Draw activity diagrams to display either business flows or like flow charts
6.	Draw component diagrams assuming that you will build your system reusing existing components along with a few new ones
7.	Draw deployment diagrams to model the runtime architecture of your system.
Group 1	
8.	Mini Project: Draw all UML diagrams for your project work.
9.	Mini Project: Draw following UML Diagrams for Bank Management application a. Class Diagram b. Object Diagram c. ER Diagram d. Component Diagram
410644(E) Social Network Analysis and Mining	
Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory	
Group 1:	

1.	**Graph Properties of a Real-World Network:** Write a program using python and Python notebook (.ipynb) + PDF report 1. Download the Karate Club dataset (Zachary, 1977) from NetworkX. 2. Compute: density, average path length, diameter, clustering coefficient. 3. Identify nodes with highest betweenness and degree centrality. 4. Draw the graph using spring layout; label top-5 central nodes. 5. Write a 500-word report interpreting what these metrics reveal about the social group.
2.	Study of existing social networks and calculate the social network related metrics.
3.	Analysis of social network dataset.
4.	Detection and mining of communities using various tools.
5.	Knowledge about tools related to social networks and implementation of social network visualizations using tools such as Gephi, Cytoscape.
6.	**Network Growth Model Comparison;** Jupyter notebook with embedded visualizations. 1. Generate three synthetic networks of 500 nodes: Erdős-Rényi (p=0.01), Watts-Strogatz (k=4, β=0.1), Barabási-Albert (m=2). 2. Compute and compare: degree distribution, clustering coefficient, average path length. 3. Plot degree distribution on log-log scale for each. 4. Identify which model best describes a real-world friendship network dataset. 5. Summarize findings in a comparative table.
Group 2:	
7.	**Mini Project: SNA Dashboard for a College Department** Build a system that models the co-authorship or collaboration network among faculty and students of a CS department using publicly available data (Google Scholar / ResearchGate). Module 1: Data collection: scrape faculty publication lists Module 2: Graph construction: co-authorship edges Module 3: Metric computation: centrality, density, cliques Module 4: Interactive dashboard using Gephi or D3.js
8.	**Mini-Project: Commercial Social Profile Analyzer:** Using Python (Flask, Scikit-learn), React.js Develop a web app that accepts LinkedIn/Twitter profile URLs and outputs a quantitative profile report including engagement score, network reach estimate, and category classification. Module 1: Profile data extraction (API / scraping) Module 2: Feature engineering (post frequency, avg engagement, network size) Module 3: Classification model: which influencer category? Module 4: Simple React/Flask dashboard output
410245(A) Information Retrieval	
Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory	
Group 1:	
1.	Write a program to Compute Similarity between two text documents.
2.	Implement Page Rank Algorithm.
3.	Write a program for Pre-processing of a Text Document: stop word removal.
4.	Write a map-reduce program to count the number of occurrences of each alphabetic character in the given dataset. The count for each letter should be case-insensitive (i.e., include both upper-case and lower-case versions of the letter; Ignore non-alphabetic characters).
5.	Write a program to implement simple web crawler.
6.	Write a program to parse XML text, generate Web graph and compute topic specific page
Group 2:	

7.	Mini project: Develop Document summarization system

8.	Mini Project: Develop Tweet sentiment analysis system
9.	Mini Project:Develop Fake news detection system
410245(B) GPU Programming and Architecture	
Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory	
Group 1:	
1.	Write program using OpenCL for Heterogeneous computing
2.	Write CUDA programming with some simple things such as dot product, calculation of pi using integration method etc.
3.	Write CUDA programming for matrix transpose and matrix multiplication
4.	Write OpenCL “Hello World” basic program
5.	Develop program using combining abilities of OpenGL and CUDA to accelerate the performance of simple graphics.
6.	Case study on “Review of traditional Computer Architecture
Group 2:	
	Mini Project : huge data computation
	Mini Project : Visualization to develop project for image processing and then video processing
	Mini Project : Parallel programming
	410245(C) Mobile Computing
Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory	
Group 1:	
1.	To implement a basic function of Code Division Multiple Access (CDMA) to test the orthogonally and autocorrelation of a code to be used for CDMA operation. Write an application based on the above concept.
2.	Implementation of GSM security algorithms (A3/A5/A8)
3.	Write an application that draws basic graphical primitives on the screen.
4.	Develop a native application that uses GPS location information.
5.	Design an android Application for Frame Animation
Group 2:	

6.	**Mini Project:** Create an application for Bank using spinner, intent a) Form 1: Create a new account for customer b) Form 2: Deposit money in customer account. c) Link both forms, after completing of first form the user should be directed to the second form
	d) Provide different menu options
7.	**Mini Project:** Create the module for collecting cellular mobile network performance parameters using telephony API Manager i) Nearest Base Station ii) Signal Strengths iii) SIM Module Details iv) Mobility Management Information
8.	**Mini Project:** Create the module for payment of fees for College by demonstrating the following methods. i) FeesMethod()- for calculation of fees ii) Use customized Toast for successful payment of fees iii) Implement an alarm in case someone misses out on the fee submission deadline iv) Demonstrate the online payment gateway
9.	**Mini Project:** Create an app to add of a product to SQLite database and make sure to add following features i) SMS messaging and email provision ii) Bluetooth options iii) Accessing Web services iv) Asynchronous remote method call v) Use Alert box for user notification
410245(D)Software Testing and Quality Assurance	
Any 5 assignments from group 1 and 1 Mini project from group 2 is mandatory	
Group 1:	
1.	Write TEST Scenario for Gmail Login Page
2.	TEST Scenario for Gmail Login Page
3.	Write Test cases in excel sheet for Social Media application or website
4.	Create Defect Report for Any application or web application
5.	Installation of Selenium grid and selenium Webdriver & java eclipse (automation tools).
6.	Prepare Software requirement specification for any project or problem statement
Group 2:	

7.	**Mini Project :**Software Testing and Quality Assurance Mini Project Dynamic webside of covid-19 information using HTML, CSS, JAVASCRIPT And PHP, MySQL database used to store user account, comment, and registration form details. Regular Expression testcases for testing purpose
8.	**Mini Project :**Create a small application by selecting relevant system environment / platform and programming languages. Narrate concise Test Plan consisting features to be tested and bug taxonomy. Prepare Test Cases inclusive of Test Procedures for identified Test Scenarios. Perform selective Black-box and White-box testing covering Unit and Integration test by using suitable Testing tools. Prepare Test Reports based on Test Pass/Fail Criteria and judge the acceptance of application developed
9.	**Mini Project :** Create a small web-based application by selecting relevant system environment / platform and programming languages. Narrate concise Test Plan consisting features to be tested and bug taxonomy. Narrate scripts in order to perform regression tests. Identify the bugs using Selenium WebDriver and IDE and generate test reports encompassing exploratory testing.
	410645(E): AWS Cloud Application Engineering
	Any 4 assignments from group 1 and 1 Mini project from group 2 is mandatory
Group 1:	
1.	Write a program in Python to count the number of running, stopped and terminated instances
2.	Create a Cloud Formation Template to create all the VPC Components and Launch an EC2 instance in the VPC created
3.	Create a Lambda function to receive the details from S3 bucket and display those details
4.	Create a REST based API to implement CRUD Operations for DynamoDB
5.	Implement Code Commit for a sample web application
Group 2:	
6.	**Mini Project :** Implement CodeBuild and Diploy for a sample web application
7.	**Mini Project :** Select a web application for deployment on AWS Infrastructure. Create an architecture diagram for the deployment. Launch an architecture by developing a template using CloudFormation / Terraform. After the infrastructure is ready deploy the web application using CI/CD Pipeline

@TheCO-POMappingMatrix

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

SavitribaiPhulePuneUniversity
Fourth Year of Computer Science (2019 Course) 410248:
Project Work Stage I

Teaching Scheme:	Credit	Examination Scheme:
Practical:02Hours/Week	02	Oral/Presentation: 50Marks

CourseObjectives:

- To Apply the knowledge for solving realistic problem
- To develop problem solving ability
- To Organize, sustain and report on a substantial piece of team work over a period of several months
- To Evaluate alternative approaches, and justify the use of selected tools and methods
- To Reflect upon the experience gained and lessons learned
- To Consider relevant social, ethical and legal issues
- To find information for yourself from appropriate sources such as manuals, books, research journals and from other sources, and in turn increase analytical skills.
- To Work in Team and learn professionalism

Course Outcomes:

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

- Solve real life problems by applying knowledge.
- Analyze alternative approaches, apply and use most appropriate one for feasible solution.
- Write precise reports and technical documents in a nutshell.
- Participate effectively in multi-disciplinary and heterogeneous teams exhibiting team work
- Inter-personal relationships, conflict management and leadership quality.

Guidelines

Project work Stage – I is an integral part of the Project work. In this, the student shall complete the partial work of the Project which will consist of problem statement, literature review, SRS, Model and Design. The student is expected to complete the project at least up to the design phase. As a part of the progress report of project work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected project topic. The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute. The examinee will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on work undergone, content delivery, presentation skills, documentation, question-answers and report.

Follow guidelines and formats as mentioned in Project Workbook recommended by Board of Studies

Savitribai Phule Pune University
Fourth Year of Engineering (2019 Course)
410249: Audit Course 7

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

Criteria

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

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

- 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
AC7-I	MOOC- Learn New Skills
AC7-II	Entrepreneurship Development
AC7-III	Botnet of Things
AC7-IV	3D Printing
AC7-V	Industrial Safety and Environment Consciousness

Savitribai Phule Pune University
Fourth Year of Engineering (2019 Course)
410249: Audit Course 7
AC7 – I: MOOC-learn New Skill

This course aims to create awareness among the students regarding various courses available under MOOC and learn new skills through these courses.

Course Objectives:

- To promote interactive user forums to support community interactions among students, professors, and experts
- To promote learn additional skills anytime and anywhere
- To enhance teaching and learning on campus and online

Course Outcomes:

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

CO1: To acquire additional knowledge and skill.

About Course

MOOCs (Massive Open Online Courses) provide affordable and flexible way to learn new skills, pursue lifelong interests and deliver quality educational experiences at scale. Whether you'reinterested in learning for yourself, advancing your career or leveraging online courses to educate your workforce, SWYAM, NPTEL, edx or similar ones can help. World's largest SWAYAM MOOCs, a new paradigm of education for anyone, anywhere, anytime, as per your convenience, aimed to provide digital education free of cost and to facilitate hosting of all the interactive courses prepared by the best more than 1000 specially chosen faculty and teachers in the country. SWAYAM MOOCs enhances active learning for improving lifelong learning skills by providing easy access to global resources.

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effortis to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy. This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses.

The courses hosted on SWAYAM is generally in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology. In order to ensure best quality content are produced and delivered, seven National Coordinators have been appointed: They are NPTEL for engineering and UGC for post-graduation education.

Guidelines:

Instructors are requested to promote students to opt for courses (not opted earlier) with proper mentoring. The departments will take care of providing necessary infrastructural and facilities for the learners.

References:

1. https://swayam.gov.in/
2. https://onlinecourses.nptel.ac.in/
3. https://www.edx.org

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2019 Course)
410249: Audit Course 7
AC7 – II: Entrepreneurship Development

This Course aims at instituting Entrepreneurial skills in the students by giving an overview of, who the entrepreneurs are and what competences are needed to become an entrepreneur

Course Objectives:

- To introduce the aspects of Entrepreneurship
- To acquaint with legalities in product development
- To understand IPR, Trademarks, Copyright and patenting
- To know the facets of functional plans, Entrepreneurial Finance and Enterprise Management

Course Outcomes:

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

CO1: Understand the legalities in product development
CO2: Undertake the process of IPR, Trademarks, Copyright and patenting
CO3: Understand and apply functional plans
CO4: Manage Entrepreneurial Finance
CO5: Inculcate managerial skill as an entrepreneur

Course Contents

1. Introduction: Concept and Definitions, Entrepreneur v/s Intrapreneur; Role of entrepreneurship in economic development; Entrepreneurship process; Factors impacting emergence of entrepreneurship; Managerial versus entrepreneurial Decision Making; Entrepreneur v/s Investors; Entrepreneurial attributes and characteristics; Entrepreneurs versus inventors; Entrepreneurial Culture; Women Entrepreneurs; Social Entrepreneurship; Classification and Types of Entrepreneurs; EDP Programmers; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs.

2. Creating Entrepreneurial Venture : Generating Business idea- Sources of Innovation, methods of generating ideas, Creativity and Entrepreneurship; Business planning process; Drawing business plan; Business plan failures; Entrepreneurial leadership – components of entrepreneurial leadership; Entrepreneurial Challenges; Legal issues – forming business entity, considerations and Criteria, requirements for formation of a Private/Public Limited Company, Intellectual Property Protection - Patents Trademarks and Copyrights.

3. Functional plans: Marketing plan–for the new venture, environmental analysis, steps in preparing marketing plan, marketing mix, contingency planning; Organizational plan – designing organization structure and Systems; Financial plan – pro forma income statements, Ratio Analysis.

4. Entrepreneurial Finance: Debt or equity financing, Sources of Finance - Commercial banks, private placements, venture capital, financial institutions supporting entrepreneurs; Lease Financing; Funding opportunities for Startups in India. 5. Enterprise Management: Managing growth and sustenance- growth norms; Factors for growth; Time management, Negotiations, Joint ventures, Mergers and acquisition

Books:

1. Kumar, Arya,`` Entrepreneurship: Creating and Leading an Entrepreneurial Organization"", Pearson ISBN-10: 8131765784; ISBN-13: 978-8131765784
2. Hishrich., Peters, ``Entrepreneurship: Starting, Developing and Managing a New Enterprise"", ISBN 0-256-14147- 9
3. Irwin Taneja, ``Entrepreneurship,"" Galgotia Publishers. ISBN: 978-93-84044-82-4
4. Charantimath, Poornima, ``Entrepreneurship Development and Small Business Enterprises,"" Pearson Education, ISBN, 8177582607, 9788177582604.

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2019 Course)
410249: Audit Course 7
AC7 – III: Botnet of Things

This course aims to provide an understanding of the various security attacks and knowledge to recognize and remove common coding errors that lead to vulnerabilities. It gives an outline of the techniques for developing a secure application.

Course Objectives:

- To Understand the various IoT Protocols
- To Understand the IoT Reference Architecture and Real World Design Constraints
- To learn the concept of Botnet

Course Outcomes:

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

CO1: Implement security as a culture and show mistakes that make applications vulnerable to attacks.

CO2: Understand various attacks like DoS, buffer overflow, web specific, database specific, web -spoofing attacks.

CO3: Demonstrate skills needed to deal with common programming errors that lead to most securityproblems and to learn how to develop secure applications

Course Contents

1. Introduction

2. IRC-Based Bot Networks

3. Anatomy of a Botnet: The Gaobot Worm

4. IoT Senosors and Security : Sensors and actuators in IoT, Communication and networking in IoT, Real-time data collection in IoT, Data analytics in IoT , IoT applications and requirements, Securitythreats and techniques in IoT, Data trustworthiness and privacy in IoT, Balancing utility and other design goals in IoT , Future of Botnets in the Internet of Things, Thingbots, Elements of Typical IRC Bot Attack , Malicious use of Bots and Botnet

5. Service Layer Protocols and Security : Security: PHP Exploits, Cross-Site Scripting and Other Browser-Side Exploits, Bots and Botnets, Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols –MAC 802.15.4 , 6LoWPAN, RPL, Application Layer Transport and Session layer protocols-transport Layer (TCP, MPTCP, UDP, DCCP, SCTP) - (TLS, DTLS) –

Session Layer - HTTP, CoAP, XMPP, AMQP, MQTT

Books:

1. Bernd Scholz - Reiter, Florian Michahelles, “Architecting the Internet of Things”, Springer ISBN 978 –3 – 642 – 19156 - 5 e - ISBN 978 – 3 -642 - 19157 - 2,
2. Threat Modeling, Frank Swiderski and Window Snyder,Microsoft Professional, 1 st Edition 2004
3. Gunter Ollmann 2007. The Phishing Guide Understanding and Preventing Phishing Attacks. IBM Internet Security Systems.
4. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978 – 1 – 118 – 47347 - 4, Willy Publications
5. White Papers :- https://www.sans.org/reading-room/whitepapers/malicious/bots-botnet-overview-1299
6. https://www-01.ibm.com/marketing/iwm/dre

Mike Kuniavsky, “Smart Things: Ubiquitous Computing User Experience Design,” Morgan Kaufmann Publishers.

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410249: Audit Course 7
AC7 – IV: 3D Printing

This course aims to provide knowledge of 3D printing devices and explore the business side of 3D printing.

Course Objectives:

- To **acquire** basic knowledge of drafting terminology and construction of geometrical figures using drawing instruments, procedure to prepare a drawing sheet as per SP-46:2003
- To **inculcate** skill of technical sketching, multi-view drawings, Lettering, tolerance, and metricconstruction
- To **impart** practical aspects to generate detailed and assembly views with dimensions, annotations,in 3D Modeling software.
- To **develop** prototype/ end use product for 3D Printing

Course Outcomes:

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

CO1: Understand the basic knowledge of Shop Floor Safety rules and regulations basics of Machinetools and 3D printing machines

CO2: Understand the concept of concept of technical sketching, multi-view drawings, Lettering,tolerance, and metric construction

CO3:Identify and Distinguish drafting terminologies and construction of geometrical figures using drawing instruments, procedure to prepare a drawing sheet as per SP-46:2003

CO4:Describe and Explain practical aspects to generate detailed and assembly views with dimensions,annotations, in 3D Modeling software.

CO5: Apply concepts and **Fabricate** the simple mechanical parts, prototype/ end use product for 3D Printing

Course Contents

1. Getting Started with 3D Printing: How 3D Printers Fit into Modern Manufacturing, Exploring theTypes of 3D Printing, Exploring Applications of 3D Printing.

2. Outlining 3D Printing Resources: Identifying Available Materials for 3D Printing, Identifying Available Sources for 3D Printable Objects.

3. Exploring the Business Side of 3D Printing: Commoditizing 3D Printing, Understanding 3D Printing's Effect on Traditional lines of Business, Reviewing 3D Printing Research.

4. Employing Personal 3D printing Devices: Exploring 3D printed Artwork, Considering Consumer level 3D Printers, Deciding on RepEap of Your Own.

Books:

1. Richard Horne, Kalani Kirk Hausman, " 3D Printing for Dummies", Taschenbuch, ISBN: 9781119386315

2. Greg Norton, "3D Printing Business - 3D Printing for Beginners - How to 3D Print",ISBN:9781514785669

2. Liza Wallach Kloski and Nick Kloski, " Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution", Maker Media, ISBN: 1680450204

4.Jeff Heldrich , "3D Printing: Tips on Getting Started with 3D Printing to Help you make Passive income for your Business"

Savitribai Phule Pune University, Pune
Fourth Year of Computer Science (2019 Course)
410249: Audit Course 7
AC7 – V: Industrial Safety and Environment Consciousness

This course aims to provide knowledge of industrial safety performance planning and accident prevention.

Course Objectives:

- To understand Industrial hazards and Safety requirements with norms
- To learn the basics of Safety performance planning
- To know the means of accident prevention
- To understand the impact of industrialization on environment
- To know the diversified industrial requirements of safety and security

Course Outcomes:

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

CO1: Develop the plan for Safety performance
CO2: Demonstrate the action plan for accidents and hazards
CO3: Apply the safety and security norms in the industry
CO4: Evaluate the environmental issues of Industrialization

Course Contents

1. Introduction: Elements of safety programming, safety management, Upgrading developmental programmers: safety procedures and performance measures, education, training and development in safety.

2. Safety Performance Planning

Safety Performance: An overview of an accident, It is an accident, injury or incident, The safety professional, Occupational health and industrial hygiene. Understanding the risk: Emergency preparedness and response, prevention of accidents involving hazardous substances.

3. Accident Prevention

What is accident prevention?, Maintenance and Inspection, Monitoring Techniques, General Accident Prevention, Safety Education and Training.

4. Organization Safety

Basic Elements of Organized Safety, Duties of Safety Officer, Safe work Practices, Safety Sampling and Inspection, Job Safety Analysis(JSA), Safety Survey, On- site and Off-site Emergency Plan, Reporting of Accidents and Dangerous Occurrences.

5. Industrial Pollution

Introduction, Work Environment, Remedy, pollution of Marine Environment and Prevention, Basic Environmental Protection Procedures, Protection of Environment in Global Scenario, Greenhouse Gases, Climate Change Impacts, GHG Mitigation Options, Sinks and Barriers,

6. Industrial Security(Industry wise)

General security Systems in Factories, Activation Security, Computer Security, Banking Security, V.I.P. Security, Women Security, Event Security, Security in Open Environments.

Books :

1. Basudev Panda ,"Industrial Safety, Health Environment and Security",Laxmi Publications, ISBN-10: 9381159432, 13: 978-9381159439

2. L.M. Deshmukh, "Industrial Safety Management", TMH , ISBN: 9780070617681

SEMESTER VIII

Home

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410250: Quantum Computing

Home

Teaching Scheme: TH: 4 Hours/Week	Credit 3	Examination Scheme:100 Mid-Semester : 30 Marks End- Sem : 70 Marks

Prerequisite Courses: Data Structures and Algorithms(210243), Data Science and Big Data Analytics (310251)

Companion Course: Laboratory Practice IV(410247)

Course Objectives:

- To provide introduction and necessary expertise to the learner in the upcoming discipline of Quantum Computing and Machine Learning.
- To enable the students to learn Quantum Computing and Quantum Machine Learning in practical-oriented learning sessions so that he/she can independently use existing open-source Quantum Computing Hardware and Software Frameworks
- To teach the students to develop hybrid solutions by applying Quantum Machine Learning to potential business application areas.
- To study Quantum Information Theory and Quantum Computing Programming Model of Computation.
- To study Quantum Algorithms and apply these to develop hybrid solutions .
- To study Quantum Concepts necessary for understanding the Quantum Computing Paradigm and compare the available hardware and software infrastructure and frameworks made available open source by major players in the Industry and Academia.

Course Outcomes:

On completion of the course, student will be able to–
CO1: To understand the concepts of Quantum Computing
CO2: To get exposure to mathematical foundation and quantum mechanics.
CO3: To implement building blocks of Quantum circuits
CO4: To understand quantum information, its processing and Simulation tools
CO5: To understand basic signal processing algorithms FT, DFT and FFT
CO6 : To study and solve examples of Quantum Fourier Transforms and their applications

Course Contents

Unit I	Introduction to Quantum Computing	07 Hours

Fundamental Concepts of Quantum computing: Introduction and Overview, Global Perspective, Quantum Bits, Quantum Computation, Quantum Algorithms, Quantum information and Quantum information processing.

#Exemplar/Case Studies	Exploring Superposition and Entanglement on IBM Quantum
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Mathematical foundation of Quantum Computing	07 Hours

Quantum Mechanics: Linear Algebra and Quantum mechanics, Postulates of Quantum mechanics, state space, evolution, Quantum measurement, distinguishing quantum states, projective measurements, POVM measurements, Phase, Composite systems, Global view and applications, Density operator

#Exemplar/Case Studies	Designing and Optimizing a Quantum Adder Circuit

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

Unit III	**Building Blocks for Quantum Program**	**07 Hours**

Quantum Computations: Quantum circuits, Quantum algorithms and qubit operations, Controlled operations, Principal deferred and Principal implicit Measurements, Universal Quantum Gates, Two level unitary gates, single qubit and CNOT , discrete set of universal operations, Quantum computational complexity

#Exemplar/Case Studies	Implementing and Benchmarking Grover's Algorithm for Graph Coloring
***Mapping of Course Outcomes for UnitIII**	CO3

Unit IV	**Quantum Simulation Algorithms and Fourier Transform**	**07 Hours**

Simulation of Quantum Systems, Simulation in action,exponential complexity growth of quantum systems,, Quantum simulation algorithm, examples of quantum simulations, perspectives of quantum simulation, Understanding Basics of Fourier transform, Discrete Fourier Transform, Fast Fourier Transform, Definitions, mathematical representations of FT, DFT and FFT

#Exemplar/Case Studies	Implementing Shor's Algorithm for N=15 in Qiskit
***Mapping of Course Outcomes for UnitIV**	**CO4**

Unit V	**Quantum Fourier Transform and Applications**	**07 Hours**

Quantum Fourier Transform , Phase estimation performance and requirements, order finding application, factoring application, General applications of Quantum Fourier transform, period finding, discrete algorithms, Other Quantum Algorithms.

#Exemplar/Case Studies	Implementing the 3-Qubit Bit-Flip Code in Qiskit with Noise.
***Mapping of Course Outcomes for Unit V**	CO5

Unit VI	**Quantum Machine Learning**	**07 Hours**

Quantum Machine Learning and Quantum AI, Quantum Neural Networks, Quantum Natural Language Understanding, Quantum Cryptography, Application Domains for Quantum Machine Learning: Chemistry/Material Science, Space Tech, Finance related Optimisation Problems, Swarm Robotics, Cyber security

#Exemplar/Case Studies	Simulating BB84 QKD Protocol and Detecting Eavesdropping.
***Mapping of Course Outcomes for Unit VI**	CO6

Learning Resources

Text Books:

1. Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University
2. Wittek, "Quantum Machine Learning (What Quantum Computing Means to Data Mining)", Peter University of Boras, Sweden - Elsevier Publications
3. Andreas Winchert, "Principles of Quantum Artificial Intelligence",Instituto Superior Técnico - Universidade de Lisboa, Portugal - World Scientific Publishing, British Library Cataloguing-in-Publication Data

1. Press Stephen Kan, "MetricsandModelsinSoftwareQualityEngineering‖,Pearson,ISBN-10:0133988082; ISBN-13:978-0133988086
2. Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University PressStephen Kan, ―Metrics and Models in Software Quality Engineering‖, Pearson, ISBN-10: 0133988082; ISBN-13: 978-0133988086
3. David McMahon, "Quantum Computing Explained", Wiley
4. Microsoft Quantum Development Kithttps://www.microsoft.com/enus/quantum/development-kit Forest SDK PyQuil: https://pyquil.readthedocs.io/en/stable/
5. Amazon Bracket Documentation on AWS:https://aws.amazon.com/braket/ 7 D-Wave Systems Documentation: https://docs.dwavesys.com/docs/latest/index.html

e-Books :

1. http://mmrc.amss.cas.cn/tlb/201702/W020170224608149940643.pdf
2. http://mmrc.amss.cas.cn/tlb/201702/W020170224608150244118.pdf

MOOC Courses Links:

1. https://onlinecourses.nptel.ac.in/noc21_cs103/preview
2. https://www.coursera.org/learn/introduction-to-quantum-information

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410251: Deep Learning

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

Prerequisite Courses: Machine Learning (410242)

Companion Course: Laboratory Practice V(410254)

Course Objectives:

- To understand the basics of neural networks.
- Comparing different deep learning models.
- To understand the Recurrent and Recursive nets in Deep Learning
- To understand the basics of deep reinforcement Learning models.
- To analyze Types of Networks.
- To Describe Reinforcement Learning.

Course Outcomes:

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

CO1: Understand the basics of Deep Learning and apply the tools to implement deep learning applications

CO2: Evaluate the performance of deep learning models (e.g., with respect to the bias-variance trade-off, overfitting and underfitting, estimation of test error).

CO3: To apply the technique of Convolution (CNN) and Recurrent Neural Network (RNN) for implementing Deep Learning models

CO4: To implement and apply deep generative models.

CO5: Construct and apply on-policy reinforcement learning algorithms

CO6:To Understand Reinforcement Learning Process

Course Contents

Unit I	Foundations of Deep learning	07 Hours

What is machine learning and deep learning?,Supervised and Unsupervised Learning, bias variance tradeoff, hyper parameters, under/over fitting regularization, Limitations of machine learning, History of deep learning, Advantage and challenges of deep learning. Learning representations from data , Understanding how deep learning works in three figures, Common Architectural Principles of Deep Network, Architecture Design, Applications of Deep learning, Introduction and use of popular industry tools such as TensorFLow, Keras, PyTorch, Caffe, Shogun.

#Exemplar/Case Studies	Deep Mind, AlphaGo, Boston Dynamics
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Deep Neural Networks(DNNs)	07 Hours

Introduction to Neural Networks :The Biological Neuron, The Perceptron, Multilayer Feed-Forward Networks , **Training Neural Networks** :Backpropagation and Forward propagation **Activation Functions** :Linear ,Sigmoid, Tannh, Hard Tanh, Softmax, Rectified Linear, **Loss Functions** :Loss Function Notation , Loss Functions for Regression , Loss Functions for Classification, Loss Functions for Reconstruction, **Hyperparameters** : Learning Rate, Regularization, Momentum, Sparsity, Deep Feedforward Networks – Example of Ex OR, Hidden Units, cost functions, error backpropagation, Gradient-Based Learning, Implementing Gradient Descent, vanishing and Exploding gradient descent, Sentiment Analysis, Deep Learning with Pytorch, Jupyter, colab.

#Exemplar/CaseStudies	A Case Study for Music Genre Classification
***Mapping of Course Outcomes for Unit II**	CO2

Unit III	**Convolution Neural Network(CNN)**	**07 Hours**

Introduction, CNN architecture overview, The Basic Structure of a Convolutional Network- Padding, Strides, Typical Settings, the ReLU layer, Pooling, Fully Connected Layers, The Interleaving between Layers, Local Response Normalization, Training a Convolutional Network

#Exemplar/Case Studies	AlexNet, VGG
***Mapping of Course Outcomes for Unit III**	CO3

Unit IV	**Convolution Neural Network(CNN)**	**07 Hours**

Recurrent and Recursive Nets: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Echo State Networks, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs, Optimization for Long-Term Dependencies, Explicit Memory. **Practical Methodology**: Performance Metrics, Default Baseline Models, Determining Whether to Gather More Data, Selecting Hyper parameters.

#Exemplar/Case Studies	Multi-Digit Number Recognition
***Mapping of Course Outcomes for Unit IV**	CO3

Unit V	**Deep Generative Models**	**08 Hours**

Introduction to deep generative model, Boltzmann Machine, Deep Belief Networks, Generative adversarial network (GAN), discriminator network, generator network, types of GAN, Applications of GAN networks

#Exemplar/Case Studies	GAN for detection of real or fake images
***Mapping of Course Outcomes for Unit V**	CO4

Unit VI	**Reinforcement Learning**	**07 Hours**

Introduction of deep reinforcement learning, Markov Decision Process, basic framework of reinforcement learning, challenges of reinforcement learning, Dynamic programming algorithms for reinforcement learning,Q Learning and Deep Q-Networks, Deep Q recurrent networks, Simple reinforcement learning for Tic-Tac-Toe.

#Exemplar/Case Studies	Self driving cars, Deep learning for chatbots
***Mapping of Course Outcomes for Unit VI**	CO5

Learning Resources

Text Books:

1. Goodfellow, I., Bengio, Y.,,Courville, A, "Deep Learning", MIT Press, 2016.
2. Josh Patterson & Adam Gibson, "Deep Learning"
3. Charu Agarwal, "Neural Networks and deep learning", A textbook
4. Nikhil Buduma, "Fundamentals of Deep Learning", SPD
5. Francois chollet, "Deep Learning with Python"

Reference Books:

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction"
2. by SethWeidman, "Deep Learning from Scratch: Building with Python from First Principles"O'Reily
3. Francois Duval, "Deep Learning for Beginners, Practical Guide with Python and Tensorflow"

e-Books :

1. http://csis.pace.edu/ctappert/cs855-18fall/DeepLearningPractitionersApproach.pdf
2. https://www.dkriesel.com/_media/science/neuronalenetze-en-zeta2-1col-dkrieselcom.pdf

MOOC Courses Links:

- https://www.my-mooc.com/en/categorie/deep-learning

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
Elective V
410252(A): Natural Language Processing

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

Prerequisite Courses: Discrete Mathematics (210241), Theory of Computation (310242), Data Science and Big Data Analytics (310251)

Companion Course: Laboratory Practice VI(410255)

Course Objectives:

- To be familiar with fundamental concepts and techniques of natural language processing (NLP)
- To acquire the knowledge of various morphological, syntactic, and semantic NLP tasks
- To develop the various language modeling techniques for NLP
- To use appropriate tools and techniques for processing natural languages
- To comprehend the advance real world applications in NLP domain.
- To Describe Applications of NLP and Machine Translations.

Course Outcomes:

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

CO1: Describe the fundamental concepts of NLP, challenges and issues in NLP

CO2: Analyze Natural languages morphologically, syntactical and semantically OR Describe the concepts of morphology, syntax, semantics of natural language

CO3: Illustrate various language modelling techniques

CO4: Integrate the NLP techniques for the information retrieval task

CO5: Demonstrate the use of NLP tools and techniques for text-based processing of natural languages

CO6: Develop real world NLP applications

Course Contents

Unit I	Introduction to Natural Language Processing	07 Hours

Introduction: Natural Language Processing, Why NLP is hard? Programming languages Vs Natural Languages, Are natural languages regular? Finite automata for NLP, Stages of NLP, Challenges and Issues(Open Problems) in NLP, **Basics of text processing:** Tokenization, Stemming, Lemmatization, Part of Speech Tagging

#Exemplar/Case Studies	Why English is not a regular language: http://cs.haifa.ac.il/~shuly/teaching/08/nlp/complexity.pdf#page=20
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Language Syntax and Semantics	07 Hours

Morphological Analysis: What is Morphology? Types of Morphemes, Inflectional morphology & Derivational morphology, Morphological parsing with Finite State Transducers (FST) **Syntactic Analysis:** Syntactic Representations of Natural Language, Parsing Algorithms, Probabilistic context-free grammars, and Statistical parsing, **Semantic Analysis:** Lexical Semantic, Relations among lexemes & their senses – Homonymy,Polysemy, Synonymy, Hyponymy, WordNet, Word Sense Disambiguation (WSD), Dictionary based approach, Latent Semantic Analysis	
#Exemplar/CaseStudies	Study of Stanford Parser and POS Tagger https://nlp.stanford.edu/software/lex-parser.html https://nlp.stanford.edu/software/tagger.html
***Mapping of Course Outcomes for Unit II**	CO2
Unit III	**Language Modelling** **07 Hours**
Probabilistic language modeling, Markov models, Generative models of language, Log-Liner Models, Graph-based Models, **N-gram models:** Simple n-gram models, Estimation parameters and smoothing, Evaluating language models, **Word Embeddings/ Vector Semantics:** Bag-of-words, TFIDF, word2vec, doc2vec, Contextualized representations (BERT), **Topic Modelling**: Latent Dirichlet Allocation (LDA), Latent Semantic Analysis, Non Negative Matrix Factorization	
#Exemplar/Case Studies	Study of language modelling for Indian languages.
***Mapping of Course Outcomes for Unit III**	CO3
Unit IV	**Information Retrieval using NLP** **07 Hours**
Information Retrieval: Introduction, Vector Space Model, **Named Entity Recognition:** NER System Building Process, Evaluating NER System, Entity Extraction, Relation Extraction, Reference Resolution, Coreference resolution, Cross, Lingual Information Retrieval	
#Exemplar/Case Studies	Natural Language Processing based Information Extraction & Retrieval: https://www.cdac.in/index.aspx?id=mc_cli_cross_lingual_info
***Mapping of Course Outcomes for Unit IV**	CO4
Unit V	**NLP Tools and Techniques** **08 Hours**
Prominent NLP Libraries: Natural Language Tool Kit (NLTK), spaCy, TextBlob, Gensim etc. **Linguistic Resources:** Lexical Knowledge Networks, WordNets, Indian Language WordNet (IndoWordnet), VerbNets, PropBank, Treebanks, Universal Dependency Treebanks Word Sense Disambiguation: Lesk Algorithm Walker's algorithm, WordNets for Word Sense Disambiguation	
#Exemplar/Case Studies	Hindi Wordnet: https://www.cfilt.iitb.ac.in/wordnet/webhwn/ Sanskrit WordNet: https://www.cfilt.iitb.ac.in/wordnet/webswn/ Indic Library: http://anoopkunchukuttan.github.io/indic_nlp_library/
***Mapping of Course Outcomes for Unit V**	CO5
Unit VI	**Applications of NLP** **07 Hours**

Machine Translation: Rule based techniques, Statistical Machine Translation (SMT), Cross Lingual Translation, Sentiment Analysis, Question Answering, Text Entailment, Discourse Processing, Dialog and Conversational Agents, Natural Language Generation

#Exemplar/Case Studies	Study working of Google Translate Study working of IBM Watson Natural Language Processing
***Mapping of Course Outcomes for Unit VI**	CO6

Learning Resources

Text Books:

1. Jurafsky, David, and James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing", Computational Linguistics and Speech Recognition‖, ,PEARSON Publication
2. Manning, Christopher D., and nrich Schütze , "Foundations of Statistical Natural Language Processing", Cambridge, MA: MIT Press

Reference Books:

1. Steven Bird, Ewan Klein, Edward Loper, "Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit", O'Reilly Publication
2. Dipanjan Sarkar , "Text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from your Data", Apress Publication ISBN: 9781484223871
3. Alexander Clark, Chris Fox, and Shalom Lappin, "The Handbook of Computational Linguistics and Natural Language Processing", Wiley Blackwell Publications
4. Jacob Eisenstein, "Natural Language Processing", MIT Press
5. Jacob Eisenstein, "An Introduction to Information Retrieval", Cambridge University Press

e-Books :

1. https://web.stanford.edu/~jurafsky/slp3/ed3book.pdf
2. https://www3.cs.stonybrook.edu/~cse521/L16NLP.pdf

NPTEL Courses links:

- https://nptel.ac.in/courses/106101007
- https://nptel.ac.in/courses/106106211

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science(2019 Course)
Elective V
410252 (B): Image Processing

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

Prerequisites Courses: Discrete Mathematics (210241)

Companion Course: Laboratory Practice VI (410255)

Course Objectives:

- To Understand Digital Image Processing Concepts.
- To Study Various Methods for Image Enhancement using Spatial and Frequency Domain.
- To Learn Classification Techniques for Image Segmentation.
- To Understand Image Compression and Object Recognition.
- To Study Various Image Restoration Techniques.
- To Understand various Medical and Satellite Image Processing Applications.

Course Outcomes:

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

CO1: Apply Relevant Mathematics Required for Digital Image Processing.

CO2: Apply Special and Frequency Domain Method for Image Enhancement.

CO3: Apply algorithmic approaches for Image segmentation.

CO4: Summarize the Concept of Image Compression and Object Recognition.

CO5: Explore the Image Restoration Techniques.

CO6: Explore the Medical and Satellite Image Processing Applications.

Course Contents

Unit I	Introduction to Digital Image Processing	07 Hours

Introduction, Fundamental steps in Digital Image Processing, Components, Elements of visual perception, Image Sensing and Acquisition, Image Sampling and Quantization, Relationships between pixels, different Color Models, Image Types, Image File Formats, Component Labeling algorithm. Introduction to OpenCV tool to Open and Display Images using Python or Eclipse C/C++.

#Exemplar/Case Studies	Write a program to create a simple image file, save the same in .jpg, .tiff, .bmp format and display it.
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Image Enhancement	08 Hours

. Introduction to Image Enhancement and its Importance, Types of Image Enhancement- **Spatial Domain Image Enhancement:** Intensity Transformations, Contrast Stretching, Histogram Equalization, Correlation and Convolution, Smoothing Filters, Sharpening Filters, Gradient and Laplacian, **Frequency Domain Image Enhancement:** Low Pass filtering in Frequency Domain (Ideal,

Butterworth, Gaussian), High Pass filter in Frequency Domain (Ideal, Butterworth, Gaussian).	
#Exemplar/Case Studies	Write a program for image enhancement using suitable algorithm forHistogram equalization, Local enhancement, Smoothing and Sharpening.
***Mapping of Course Outcomes for Unit II**	CO2

Unit III	**Image Segmentation and Analysis**	**08 Hours**

Introduction to Image Segmentation and its need. **Classification of Image Segmentation Techniques:** Threshold Based Image Segmentation, Edge Based Segmentation, Edge Detection, Edge Linking, Hough Transform, Watershed Transform, Clustering Techniques, region approach

#Exemplar/Case Studies	Studythe different image segmentation techniques for image segmentation
***Mapping of Course Outcomes for Unit III**	CO3

Unit IV	**Image Compression and Object Recognition**	**06 Hours**

Image Compression: Introduction to Image Compression and its need, Classification of Image Compression Techniques- run-length coding, Shannon Fano coding, Huffman coding, Scalar and vector quantization, Compression Standards-JPEG/MPEG, Video compression. **Object Recognition:** Introduction, Computer Vision, Tensor Methods in Computer Vision, Classifications Methods and Algorithm, Object Detection and Tracking, Object Recognition.

#Exemplar/Case Studies	Explain image compression and object recognition techniques.
***Mapping of Course Outcomes for Unit IV**	CO4

Unit V	**Image Restoration and Reconstruction**	**07 Hours**

Introduction, Model of Image degradation, Noise Models, Classification of image restoration techniques, Blind-deconvolution techniques, Lucy Richardson Filtering, Wiener Filtering

#Exemplar/Case Studies	Explain classification of image restoration techniques.
***Mapping of Course Outcomes for Unit V**	CO5

Unit VI	**Medical and Satellite Image Processing**	**07 Hours**

Medical Image Processing: Introduction, Medical Image Enhancement, Segmentation, Medical Image Analysis (Images of Brain MRI or Cardiac MRI or Breast Cancer). **Satellite Image Processing:** Concepts and Foundations of Remote Sensing, GPS, GIS, Elements of Photographic Systems, Basic Principles of Photogrammetry, Multispectral, Thermal, and Hyper spectral Sensing, Earth Resource Satellites Operating in the Optical Spectrum

#Exemplar/Case Studies	Implement application for medical image processing or satellite image processing using OpenCV or Python.

*Mapping of Course Outcomes for UnitVI	CO6

Learning Resources

Text Books:

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image processing", Pearson Education, Fourth Impression, 2008, ISBN: 978-81-7758-898- 9.
2. A. K. Jain, "Fundamentals of Digital Image Processing", PHI, ISBN-978-81- 203- 0929-6.
3. S. Annadurai, R. Shanmugalakshmi, "Fundamentals of Digital Image Processing", Pearson Education, First Edition, 2007, ISBN-8177584790.
4. Boguslaw Cyganek, "Object Detection and Recognition in Digital Images: Theory and Practice", Wiley, First Edition, 2013, ISBN: 978-0-470-97637-1.
5. Ingemar Cox, Matthew Miller, Jeffrey Bloom, Jessica Fridrich, Ton Kalker, "Digital Watermarking and Steganography", Morgan Kaufmann (MK), ISBN: 978-0-12- 372585-1.
6. Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman, "Remote Sensing and Image Interpretation", Wiley, Seventh Edition, 2015, ISBN: 978-1-118-91947-7

Reference Books :

1. Isaac Bankman, "Handbook of Medical Imaging", Academic Press, Second Edition, 2008, ISBN: 9780080559148.
2. Jayaraman, Esakkirajan,Veerakumar, "Digital image processing" , , Mc Graw Hill, Second reprint- 2010, ISBN(13): 978-0-07-01447-8, ISBN(10):0-07-014479-6.

e-Books :

- https://bookboon.com/en/3d-video-processing-and-transmission-fundamentals-ebook

MOOC Courses links :

- http://nptel.ac.in/courses/117105079.

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
Elective V
410252(C): Software Defined Networks

Teaching Scheme: TH: 3 Hours/Week	Credit: 3	Examination Scheme: Mid-Semester (TH) : 30 End-Sem (TH): 70

Prerequisites Courses: Computer Networks and Security(310244)

Companion Course: Laboratory Practice VI(410255)

Course Objectives:

- To learn the fundamentals of software defined networks and understand Differentiation between traditional networks and software defined networks
- To gain conceptual understanding of Software Defined Networking (SDN) and its rolein Data Center.
- To study about the SDN Programming.
- To study industrial deployment use-cases of SDN.
- To study about the various applications of SDN
- To Describe SDN Framework.

Course Outcomes:

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

CO1: Interpret the need of Software Defined networking solutions.
CO2: Analyze different methodologies for sustainable Software Defined Networkingsolutions.
CO3: Select best practices for design, deploy and troubleshoot of next generation networks.
CO4: Develop programmability of network elements.
CO5: Demonstrate virtualization and SDN Controllers using Open Flow protocol
CO6: Design and develop various applications of SDN

Course Contents

Unit I	Introduction	07 Hours

Challenges of traditional networks, History of Software Defined Networking (SDN), Modern Data Center – Traditional Switch Architecture – Why SDN – Evolution of SDN – How SDN Works – Centralized and Distributed Control and Date Planes.

#Exemplar/Case Studies	Video Streaming https://kempsdn.com/what-is-sdn-and-use-cases/video-streaming/
*Mapping of Course Outcomes for Unit I	CO1,CO2

Unit II	OPEN FLOW & SDN CONTROLLERS	07 Hours

Open Flow Overview, The Open Flow Switch, The Open Flow Controller, Open Flow Ports, Message Types, Pipeline Processing, Flow Tables, Matching, Instructions, Action Set and List, Open Flow Protocol, Proactive and Reactive Flow, Timers, Open Flow Limitations, Open Flow Advantages and Disadvantages, Open v Switch Features, Drawbacks of Open SDN, Introduction to SDN controller.

#Exemplar/Case Studies	Behavior Anomaly Detection in SDN Control Plane: A Case Study of Topology Discovery Attacks https://www.hindawi.com/journals/wcmc/2020/8898949/
***Mapping of Course Outcomes for Unit II**	CO2,CO3

Unit III	**DATA CENTERS**	**07 Hours**

Data Center Definition, Data Center Demands (Adding, Moving, Deleting Resources, Failure Recovery, Multitenancy, Traffic Engineering and Path Efficiency), Tunneling Technologies for the Data Center, SDN Use Cases in the Data Center, SDN Solutions for the Data Center Network – VLANs – EVPN – VxLAN – NVGRE

#Exemplar/Case Studies	The World's Second Largest Tier IV Data Center A Yotta Infrastructure case study https://www.missioncriticalmagazine.com/articles/94105-the-worlds-seconzd-largest-tier-iv-data-center
***Mapping of Course Outcomes for Unit III**	CO2

Unit IV	**SDN PROGRAMMING**	**07 Hours**

Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs – Introduction of Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications

#Exemplar/Case Studies	Case study: Ballarat Grammar uses SDN to fight malware https://www.zdnet.com/home-and-office/networking/case-study-ballarat-grammar-uses-sdn-to-fight-malware/
***Mapping of Course Outcomes for Unit IV**	CO4

Unit V	**Network Functions Virtualization (NFV)**	**07 Hours**

Definition of NFV, SDN Vs NFV, In-line network functions, Benefits of Network Functions Virtualization, Challenges for Network Functions Virtualization, Leading NFV Vendors, Comparison of NFV and NV.

#Exemplar/Case Studies	NFV deployment case study failure migrate https://www.dell.com/en-us/blog/nfv-deployment-case-study-failure-migrate/
***Mapping of Course Outcomes for Unit V**	CO5

Unit VI	**SDN Use Cases**	**07 Hours**

Juniper SDN Framework – IETF SDN Framework – Open Daylight Controller – Floodlight Controller – Bandwidth Calendaring – Data Center Orchestration

#Exemplar/Case Studies	CloudSeeds automate IaaS using SDN and a high-performance network from Juniper.
***Mapping of Course Outcomes for Unit VI**	**CO6**

Learning Resources

Text Books:

1. Paul Goransson and Chuck Black, "Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann, 2014, ISBN: 9780124166752, 9780124166844.
2. Siamak Azodolmolky, "Software Defined Networking with Open Flow", Packt Publishing, 2013, ISBN: 9781849698726
3. Thomas D. Nadeau, Ken Gray, "SDN: Software Defined Networks", An Authoritative Review of Network Programmability Technologies‖, 2013, ISBN : 10:1-4493-4230-2, 9781-4493-4230-2

Reference Books :

1. Vivek Tiwari, "SDN and Open Flow for Beginners", Amazon Digital Services, Inc., 2013.
2. Fei Hu, Editor, "Network Innovation through Open Flow and SDN: Principles and Design", CRC Press, 2014.

e-Books :

1. **https://ridhanegara.staff.telkomuniversity.ac.id/files/2017/04/Paul-Goransson-and-Chuck-Black-Auth.-Software-Defined-Networks.-A-Comprehensive-Approach.pdf**
2. **https://speetis.fei.tuke.sk/KomunikacnaTechnika1/prednasky/7_11_2016/kniha_sietovanie.pdf**
3. **https://ridhanegara.staff.telkomuniversity.ac.id/files/2017/04/Thomas-D.-Nadeau-Ken-Gray-SDN-Software-Defined-Networks-O_039_Reilly-Media-2013.pdf**

MOOC Courses Links:

- **https://nptel.ac.in/courses/108107107**

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2019 Course)Elective VI
410652(D): Wireless Sensor Network

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

Prerequisite Courses: Computer Network, 410244(A)Digital Signal Processing

Companion Course: Laboratory Practice VI(410255)

Course Objectives:

- To introduce the architecture, hardware design, operating systems, and communication standards.
- To analyze, compare, and select appropriate MAC protocols, routing mechanisms, and transport protocols for energy-constrained and application-specific WSN deployments.
- To develop competency in localization algorithms, time synchronization protocols,
- To equip with techniques for in network data aggregation, query processing, energy harvesting.
- To build expertise in WSN security protocols, privacy-preserving mechanisms,
- To expose students to real-world WSN application domains including smart agriculture, healthcare, industrial

Course Outcomes:

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

CO1: Understand the architecture, hardware components, operating systems of WSN systems.

CO2: Analyze and compare MAC protocols, routing algorithms, and transport mechanisms designed.

CO3: Apply localization, time synchronization, and topology control techniques to manage distributed sensor network deployments.

CO4: Design energy-efficient data aggregation, query processing, and storage strategies for WSN.

CO5: Evaluate security threats, privacy mechanisms, and fault-tolerance strategies applicable to WSN

CO6: Develop and assess real-world WSN applications integrating IoT, deep learning.

Course Contents

Unit I	Introduction	08 Hours

Introduction: Fundamentals of wireless communication technology, the electromagnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet.

#Exemplar/Case Studies	Intel Research Lab WSN Deployment: 150-node indoor sensor network for microclimate monitoring.
***Mapping of Course Outcomes for Unit I**	CO1

Unit II	Introduction to Adhoc/sensor networks	08 Hours

Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering.

#Exemplar/Case Studies	S-MAC in Pipeline Leak Detection: Duty-cycling for long-life underground sensor deployment.

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

Unit III	**MAC Protocols**	**08 Hours**

MAC Protocols : Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4.

#Exemplar/Case Studies	Indoor Localization in Hospital Asset Tracking: RSSI-based patient-wristband localization with 1m accuracy.
***Mapping of Course Outcomes for Unit II**	CO3

Unit IV	**Routing Protocols**	**08 Hours**

Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols

#Exemplar/Case Studies	Solar Energy Harvesting in Smart Agriculture: Perpetually operating soil-moisture sensor nodes.
***Mapping of Course Outcomes for Unit II**	CO4

Unit V	**QoS and Energy Management**	**08 Hours**

QoS and Energy Management: Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power, and system power management schemes. Healthcare and body area networks (BAN): IEEE 802.15.6, wearables, patient monitoring,

#Exemplar/Case Studies	Wormhole Attack Mitigation in Smart City WSN: TrueLink protocol for geographic routing security.
***Mapping of Course Outcomes for Unit II**	CO5

Unit VI	**WSN Applications, IoT Integration & Emerging Trends**	**08 Hours**

Precision agriculture: soil moisture, crop health, automated irrigation — end-to-end WSN design, Structural health monitoring (SHM): IEEE 802.15.6, Smart city applications: smart parking, noise mapping, waste management, predictive maintenance Industry 4.0 integration, WSN and IoT convergence: gateway architectures, Software-Defined Networking (SDN) for WSN: programmable control plane for sensor networks, 5G-integrated sensor networks.

#Exemplar/Case Studies	SHM at Golden Gate Bridge: 64-node Imote2 WSN for real-time structural vibration monitoring
***Mapping of Course Outcomes for Unit II**	CO6

Books:

Text:

1. Dr. Manish Gupta, Mr Deepak Sharma, Ms Neha Gupta, Dr. Naresh Kumar, “A Complete guide to Wireless sensor networks”, Notion Press 2021.
2. C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education – 2008.
3. Kazem Sohraby, Daniel Minoli, and Taieb Znati, "Wireless Sensor Networks: Technology, Protocols, and Applications", Wiley-Interscience, 2007.

References:

1.Shashikant V. Athawale, Ad-Hoc and Wireless Sensor network, Pearson, 2022.

2.Feng Zhao and Leonides Guibas, "Wireless sensor networks ", Elsevier publication – 2005

3.William Stallings, "Wireless Communications and Networks ", Pearson Education – 2013

eE Books:

1. IEEE 802.15.4 Standard Documentation and ZigBee Alliance Specification, available at ieee.org and zigbee.org.
2. https://jcer.in/jcer-docs/E-Learning/Digital%20Library%20/E-Books/Wireless%20Sensor%20Networks.pdf
3. https://www.google.co.in/books/edition/Wireless_Sensor_Networks/7YBHYJsSmS8C?hl=en

MOOC Courses Links:

- https://onlinecourses.nptel.ac.in/noc25_cs74/preview

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
Elective V
410252(E): Open Elective

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

The open elective included, so as to give the student a wide choice of subjects from other Engineering Programs. To inculcate the out of box thinking and to feed the inquisitive minds of the learners the idea of open elective is need of the time. Flexibility is extended with the choice of open elective allows the learner to choose interdisciplinary/exotic/future technology related courses to expand the knowledge horizons.

With this idea learner opts for the course without any boundaries to choose the approved by academic council and Board of Studies

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
Elective VI
410253(A) : Pattern Recognition

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

Prerequisite Courses: Fundamentals of Data Structures (210242), Data Structures and Algorithms(210252)

Companion Course: Laboratory Practice VI(410255)

Course Objectives:

- To learn the basic concept of Pattern recognition
- To study different approaches of pattern recognition
- To learn various pattern classification techniques
- To survey on recent advances and applications in pattern recognition
- To implement Optimal Path Searching techniques.
- To Illustrate Pattern Recognition Techniques.

Course Outcomes:

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

CO1: Analyze various type of pattern recognition techniques

CO2: Identify and apply various pattern recognition and classification approaches to solvethe problems

CO3: Evaluate statistical and structural pattern recognition

CO4: Percept recent advances in pattern recognition confined to various applications

CO5:Implement Bellman's optimality principle and dynamic programming

CO6:Analyze Patterns using Genetic Algorithms & Pattern recognition applications.

Selection of Modules:

Kindly note that modules 1,2,3 and module 9 are compulsory and select any two (02) modules from remaining modules

Course Contents

Unit I	Pattern Recognition	07 Hours

Introduction of Pattern Recognition with its application, Pattern Recognition system, Design cycle of pattern recognition, Learning and adaption, Representation of Patterns and classes, Feature Extraction, pattern recognition models/approaches.

#Exemplar/Case Studies	Evaluation on spatial and temporal variations in water quality by pattern recognition techniques.
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Error Estimation & Decision Theory	07 Hours

Introduction, Error estimation methods, various distance measures (Euclidean, Manhattan, cosine, Mahalanobis) and distance based classifier, Feature selection based on statistical hypothesis testing, ROC curve. Introduction, Bayesian decision theory-continuous and discrete features, two-category classification, minimum error rate classification, discriminant functions, Parametric Techniques:- Maximum Likelihood Estimation, Bayesian Parameter Estimation, Sufficient Statistics; Problems of dimensionality. Non-Parametric Techniques:-Density estimation, Parzen Window, Metrics and Nearest-Neighbor classification; Fuzzy classification	
#Exemplar/Case Studies	Spatial and temporal air quality pattern recognition using environ metric techniques
***Mapping of Course Outcomes for Unit II**	CO2
Unit III	**Structural pattern recognition** **06 Hours**
Tree Classifiers-Decision Trees, Random Forests, **Structural Pattern recognition:** Elements of formal grammars ,String generation as pattern description ,Recognition of syntactic description ,Parsing ,Stochastic grammars and applications ,Graph based structural representation, **Stochastic method:** Boltzmann Learning.	
#Exemplar/Case Studies	Case Study on spoken word recognition
***Mapping of Course Outcomes for Unit III**	CO3
Unit IV	**Clustering** **08 Hours**
Introduction, Hierarchical Clustering, agglomerative clustering algorithm, the single linkage, complete, linkage and average, linkage algorithm. Ward's method ,Partition clustering, , K- means algorithm, clustering algorithms based on graph theory(Minimum spanning tree algorithm),Optimization methods used in clustering: clustering using simulating Annealing.	
#Exemplar/Case Studies	Case Study on disease recognition from a list of symptoms
***Mapping of Course Outcomes for Unit IV**	CO3
Unit V	**Template Matching and Unsupervised Learning** **07 Hours**
Measures based on Optimal Path Searching techniques: Bellman's optimality principle and dynamic programming, The Edit distance, Dynamic time Warping, Measures based on correlations, Deformable template models	
#Exemplar/Case Studies	Pattern recognition in time series database: A case study on financial database.
***Mapping of Course Outcomes for Unit V**	CO4
Unit VI	**Fuzzy Logic and Pattern Recognition** **07 Hours**
Fuzzy logic,Fuzzy pattern classifiers, Pattern classification using Genetic Algorithms Pattern recognition applications: Application of pattern recognition techniques in object recognition, biometric, facial recognition, IRIS scanner, Finger prints, 3D object recognition	
#Exemplar/Case Studies	Study of fingerprint recognition

*Mapping of Course Outcomes for Unit VI	CO5

Learning Resources

Text Books:

1. R. O. Duda, P. E. Hart, D. G. Stork, "Pattern Classification", 2nd Edition, Wiley-Inter- science, John Wiley &Sons, 2001
2. S. Theodoridis and K. Koutroumbas, "Pattern Recognition", 4th Edition, Elsevier, Academic Press, ISBN: 978-1-59749-272-0
3. B.D. Ripley, "Pattern Recognition and Neural Networks", Cambridge University Press. ISBN 0 521 46086 7

Reference Books:

1. Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.
2. David G. Stork and Elad Yom-Tov, "Computer Manual in MATLAB to accompany Pattern Classification", Wiley Inter-science, 2004**,** ISBN-10: 0471429775
3. Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", PHI, ISBN-978-81-203-4091-6
4. eMedia at NPTEL : http://nptel.ac.in/courses/106108057/33

e-Books :

1. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.320.4607&rep=rep1&type=pdf
2. https://cds.cern.ch/record/998831/files/9780387310732_TOC.pdf
3. https://darmanto.akakom.ac.id/pengenalanpola/Pattern%20Recognition%204th%20Ed.%20(2009).pdf
4. https://readyforai.com/download/pattern-recognition-and-machine-learning-pdf/

MOOC Courses Links:

- https://nptel.ac.in/courses/117105101

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
Elective VI
410253(B): Soft Computing

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

Prerequisite Courses: Computer Graphics(210244)

Companion Course: Laboratory Practice VI(410255)

Course Objectives:

- To study the various soft computing approaches.
- To understand the soft computing techniques and algorithms for problem solving.
- To be familiar with the various application areas of soft computing.
- To apply the soft computing techniques for developing intelligent systems
- To Explore and solve problems using genetic Algorithms.
- To Understand hybrid systems paradigm and Application Areas of Soft Computing.

Course Outcomes:

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

CO1: Understand requirement of soft computing and be aware of various soft computing techniques.

CO2: Understand Artificial Neural Network and its characteristics and implement ANN algorithms.

CO3: Understand and Implement Evolutionary Computing Techniques.

CO4: Understand the Fuzzy logic and Implement fuzzy algorithms for solving real life problems.

CO5: Apply knowledge of Genetic algorithms for problem solving.

CO6: Develop hybrid systems for problem solving.

Course Contents

Unit I	Introduction To Soft Computing	07 Hours

Introduction to Soft Computing and Computational Intelligence, Characteristics of Soft computing, Comparison Soft Computing Vs Hard Computing, Requirements of Soft Computing, Soft Computing Techniques – Artificial Neural Network, Fuzzy Logic., Evolutionary computing and Hybrid systems, Applications of Soft Computing

#Exemplar/Case Studies	1. Study of Soft Computing techniques for Waste WaterManagement 2. Study of IBM Research Neuro-symbolic AI- a new look for neuromorphic computing
*Mapping of Course Outcomes for Unit	CO1

Unit II	Artificial Neural Network	07 Hours
Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation, functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks.Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory, perceptron model, single layer artificial neural network, multilayer perceptron model; back propagation learning methods, effect of learning rule coefficient; back propagation algorithm, factors affecting backpropagation training, applications.		
#Exemplar/CaseStudies	Study of Handwriting recognition using ANN.	
*Mapping of Course Outcomes for Unit II	CO2	

Unit III	Evolutionary Computing	07 Hours
Problem Solving as A Search Task, Hill Climbing And Simulated Annealing, Evolutionary Computing, Evolution Strategies, Evolutionary Programming, Genetic Programming, Selected Applications From The Literature: A Brief Description, Scope Of Evolutionary Computing, Introduction to Evolutionary Single-Objective Optimization, Particle Swarm Optimization: Introduction, inspiration, mathematical model, standard and binary PSO. Artificial hummingbird algorithm		
#Exemplar/Case Studies	Study of Engineering application of Artificial hummingbird algorithm	
*Mapping of Course Outcomes for Unit III	CO3	

Unit IV	Fuzzy logic	08 Hours
Introduction to Fuzzy Logic, Classical Set, Fuzzy Set- Introduction, Operations on classical sets, properties of classical sets, fuzzy set operations, properties of fuzzy sets, Classical Relation, Fuzzy Relation, **Fuzzy Inference process** – Membership functions, Fuzzification, Membership value Assignment- Inference, Rank ordering, defuzzification – Weighted Average Method, Mean-Max Membership, Fuzzy Bayesian Decision Making, **Developing a Fuzzy Control** – System Architecture and Operation of FLC System, FLC System Models, Application of FLC System		
#Exemplar/Case Studies	Study of Object Detection Robot Using Fuzzy Logic Controller	
*Mapping of Course Outcomes for Unit IV	CO4	

Unit V	Genetic Algorithm	07 Hours
Introduction To Basic Terminologies in Genetic Algorithm: Individuals, Genes, Fitness, Populations; **Simple GA; General Genetic Algorithm; Operators in Genetic Algorithm:** Encoding, Selection, Crossover (Recombination), Mutation; **Stopping Condition for GA Flow; Constraints in Genetic Algorithms; Problem Solving Using Genetic Algorithm; Holland Classifier System:** The Production System, The Bucket Brigade Algorithm and Rule Generation; **Advantages and Limitations of Genetic Algorithms; Applications of Genetic Algorithms.**		
#Exemplar/Case Studies	Use Genetic Algorithm to design a solution to the Traveling Salesman Problem. **Solution**:1. Use Permutation Encoding 2. Define Objective Function. 3. Apply Selection Method 4. Crossover 5. Mutation 6. RepeatUntil stopping criteria is met. 7.Stop	
*Mapping of Course Outcomes for Unit V	CO5	

Unit VI	Hybrid System and Application Areas of Soft Computing	07 Hours

Hybrid System towards comprehensive Soft Computing: The hybrid systems paradigm, Hybrid connectionist production systems, Hybrid connectionist logic programming systems, Hybrid fuzzy connectionist production systems, Hybrid systems for speech and language processing, Hybrid systems for decision making. **Application Areas of Soft Computing:** Fuzzy-filtered Neural Networks-Plasma Spectrum Analysis, Hand-written Numeral Recognition, Fuzzy sets and Genetic Algorithms in Game Playing, Soft Computing for Color Recipe Prediction.

#Exemplar/Case Studies	Study of Hybrid models for disease prediction.
***Mapping of Course Outcomes for Unit VI**	CO6

Learning Resources

Text Books:

1. S.N. Sivanandam, "Principles of Soft Computing", Wiley India- ISBN- 9788126527410
2. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, "Neuro-Fuzzy and Soft Computing A Computational Approach to Learning and Machine Intelligence", Prentice Hall, ISBN: 978-0132610667
3. L. N. de Castro, "Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications", 2006, CRC Press, ISBN-13: 978-1584886433 (Chapter 3)
4. S.Rajasekaran, and G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms : Synthesis, and Applications", Prentice Hall of India

Reference Books:

Reference Books :

1. Nikola K. Kasabov, "Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering", MIT Press, ISBN:978-0-262-11212-3
2. Seyedali Mirjalili, "Evolutionary Algorithms and Neural Networks Theory and Applications, Studies in Computational Intelligence", Vol 780, Springer, 2019, ISBN 978-3-319-93024-4
3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley India, ISBN: 978-0-470-74376-8

e-Books :

1. https://kamenpenkov.files.wordpress.com/2016/01/pso-m-clerc-2006.pdf
2. http://www.shahed.ac.ir/stabaii/Files/CompIntelligenceBook.pdf
3. https://ctb.iau.ir/Files/%D9%88%D8%A8%20%D8%B3%D8%A7%DB%8C%D8%AA%20%D8%A7%D8%B3%D8%A7%D8%AA%DB%8C%D8%AF/fuzzy%20logic%20with%20engineering%20application-3rdEdition.pdf
4. http://www.soukalfi.edu.sk/01_NeuroFuzzyApproach.pdf
5. https://www.yumpu.com/en/document/read/34361976/evolutionary-computation-a-unified-approach

MOOC Courses Links :

- NPTEL Course – Introduction of Soft Computing, IIT Kharagpur by Prof. Debidas Samantahttps://nptel.ac.in/courses/106105173
- NPTEL Course – Neural Network and Applications, IIT Kharagpur by Prof. Somnath Sengupta,https://nptel.ac.in/courses/117105084
- NPTEL Course – Fuzzy Logic and Neural Networks, IIT Kharagpur by Dilip Kumar Pratiharhttps://nptel.ac.in/courses/127105006

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
Elective-VI
410253C: Business Intelligence

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

Prerequisites Courses: 310241: Database Management System,310251:Data Science & Big data Analytics,410242: Machine Learning

Companion Course: 410256:Laboratory Practice VI

- **Course Objectives:**

1. To introduce the concepts and components of Business Intelligence (BI)
2. To evaluate the technologies that make up BI (data warehousing, OLAP)
3. To identify the technological architecture of BI systems·
4. To explain different data preprocessing techniques
5. To identify machine learning model as per business need
6. 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:mplement 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**	**07 Hours**

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

#Exemplar/Case Studies	Power BI Case Study – How the tool reduced hassles of Heathrow & Edsby: https://data-flair.training/blogs/power-bi-case-study/
***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 BusinessIntelligence 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**	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. PaulrajPonnian, "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
7. 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

NPTEL/YouTube video lecture links:

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

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410253(D) Reinforcement Learning

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

Prerequisite Courses: Data Structures and Algorithms(210243), Data Science and Big Data Analytics (310251)

Companion Course: Laboratory Practice IV(410247)

Course Objectives:

- To introduce the fundamental principles and theoretical foundations of Reinforcement Learning, distinguishing it from supervised and unsupervised learning paradigms.
- To equip students with the mathematical formulation of Markov Decision Processes (MDPs), Bellman equations, and value function theory for sequential decision making.
- To enable students to design, implement, and compare classical RL algorithms — Dynamic Programming, Monte Carlo, and Temporal Difference methods — for both prediction and control tasks.
- To develop competency in approximate solution methods using function approximation (linear and non-linear), eligibility traces, and semi-gradient techniques for large-scale RL problems
- To familiarize students with policy gradient methods — REINFORCE, Actor-Critic architectures — and their theoretical justification for direct policy optimization.
- To expose students to Deep Reinforcement Learning algorithms (DQN, Double DQN) and their application in complex domains such as game playing, robotics, and language model alignment.

Course Outcomes:

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

CO1: Understand the foundational concepts of Reinforcement Learning, MDP formulation.
CO2: Apply Dynamic Programming and Monte Carlo methods for policy evaluation.
CO3: Design and analyze Temporal Difference learning algorithms including SARSA and Q-Learning
CO4: Implement approximate solution methods using function approximation for large-scale RL problems
CO5: Develop and evaluate Policy Gradient and Deep Reinforcement Learning algorithms.
CO6 : Analyze and apply RL techniques to real-world case studies and emerging applications.

Course Contents

Unit I	Introduction	07 Hours

Reinforcement learning – Elements of Reinforcement learning – limitations and scope – Example Tic-tac-toe – Tabular solution methods – multi-armed bandits – k-armed bandit problem – action-value methods – 10-armed testbed – incremental implementation – tracking a non-stationary problem – optimistic initial values – Upper-confidence bound action section – gradient bandit algorithm – associative search - finite markov decision processes – agent environment interface – goals and rewards – returns and episodes – unified notation for episodic and continuing tasks – policies and value functions – optimal policies and optimal value functions – optimality and approximation

*Mapping of CourseOutcomes for Unit I	CO1

Unit II	Dynamic Programming and Monte Carlo methods	07 Hours
Policy evaluation – improvement – iteration – value iteration – Asynchronous dynamic programming – generalized policy iteration – Efficiency of DP – Monte carlo prediction – monte carlo estimation of action values – monte carlo control – without exploring starts – off-policy monte carlo control – discounting aware importance sampling – per-decision importance sampling		

*Mapping of Course Outcomes for Unit II	CO2

Unit III	Temporal difference learning and Bootstrapping	07 Hours
TD prediction – Advantages – Optimality of TD Sarsa: On policy TD control – Q-learning off-policy TD control – Expected Sarsa – Maximization Bias and double learning – Games, Afterstates and Special cases – n-step TD prediction – n-step Sarsa – n-step Off-policy learning – per-decision methods with control variates – off-policy learning without importance sampling – n-step tree backup algorithm – A unifying algorithm – n-step Q(σ) – Planning and learning with tabular methods – models and planning – prioritized sweeping – trajectory sampling – planning at decision time - rollout algorithms – monte carlo tree search		

*Mapping of CourseOutcomes for Unit III	CO3

Unit IV	Approximate solution methods	07 Hours
On-policy prediction with approximation – value-function approximation – prediction objective – stochastic gradient, semi-gradient methods – linear methods – Feature construction – Nonlinear function approximation Least squares TD – Memory based function approximation – kernel based approximation – on-policy control – Episodic semi-gradient control – Semi-gradient n-step sarsa – differential semi-gradient n-step sarsa – off-policy methods – semi-gradient methods – examples – deadly triad – Bellman error – Gradient, Emphatic TD methods – Eligibility Traces – The λ return – TD (λ) – Online λ return algorithm – Sarsa (λ) – Variable λ and γ – Watkins Q(λ) and tree-backup (λ).		

*Mapping of CourseOutcomes for Unit IV	CO3,CO4

Unit V	Policy Gradient Methods	07 Hours
Policy Parameterization and the Policy Gradient Theorem, REINFORCE: Monte Carlo Policy Gradient algorithm, REINFORCE with Baseline: Variance reduction techniques, Actor-Critic Methods: One-step and n-step Actor-Critic, Advantage Function; A2C and A3C architectures (overview), Comparison of Value-Based vs Policy-Based approaches.		

*Mapping of CourseOutcomes for Unit V	CO5

Unit VI	Deep Reinforcement learning	07 Hours
Introduction to Deep RL: Motivation and challenges (non-stationarity, correlation), Deep Q-Networks (DQN): Learning the Q-function with CNNs, Experience Replay and Target Network — DQN stabilization techniques, DQN Algorithm: End-to-end training pipeline; Hyperparameter tuning, Double DQN Algorithm: Addressing overestimation bias, Prioritized Experience Replay; Dueling Network Architecture (overview), Deep RL in continuous action spaces: DDPG, PPO (overview), Ethical considerations, safety, and deployment challenges in Deep RL, Emerging trends: Multi-agent RL, Offline RL, RL from Human Feedback (RLHF).		

*Mapping of CourseOutcomes for Unit VI	CO6

Learning Resources

Text Books:

1. Richard S Sutton and Andrew G Barto, " Reinforcement learning –2nd Edition", MIT Press, 2nd Edition, 2023
2. Laura Gresser and Loon Keng, "Foundations of Deep Reinforcement Learning: Theory and Practice in Python:, Addison and Wesley, 1st Edition, 2022.

Reference Books:

1. Marco Wiering and Martjin Van Otterlo, " Reinforcement learning State of the Art", Springer Verlag, 2012
2. Phil Winder, " Reinforcement learning: Industrial Applications of Intelligent agents", Shroff/O-Reilly, 1st Edition, 2020.
3. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT Press, 2nd Edition, 2023.
4. Laura Graesser and Loon Keng, "Foundations of Deep Reinforcement Learning: Theory and Practice in Python", Addison-Wesley, 1st Edition, 2022.

E-Books :

1. OpenAI Gym (gymnasium.farama.org) — Standard RL environments for experimentation
2. Spinning Up in Deep RL by OpenAI (spinningup.openai.com) — Practical deep RL reference
3. Sutton & Barto online textbook — incompleteideas.net/book/the-book-2nd.html
4. David Silver's RL Lectures (YouTube / UCL) — 10-lecture video series aligned to this syllabus
5. Stable Baselines3 (Python library) — Production-grade implementations of RL algorithms
6. PyTorch / TensorFlow — Deep learning frameworks used for DQN and policy gradient labs

MOOC Courses Links:

1.https://onlinecourses.nptel.ac.in/noc19_cs55/preview

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

Savitribai Phule Pune University Fourth Year of Computer Engineering (2019 Course)Elective IV 410253(E): Open Elective		
Teaching Scheme: **TH: 03Hours/Week**	**Credit** **03**	**Examination Scheme:** **In-Sem (Paper): 30 Marks** **End-Sem (Paper): 70 Marks**
Companion Course: Laboratory Practice VI (410255)		

The open elective included, so as to give the student a wide choice of subjects from other Engineering Programs. To inculcate the out of box thinking and to feed the inquisitive minds of the learners the idea of open elective is need of the time. Flexibility is extended with the choice of open elective allows the learner to choose interdisciplinary/exotic/future technology related courses to expand the knowledge horizons.With this idea learner opts for the course without any boundaries to choose the approved by academic council and Board of Studies.

Savitribai Phule Pune University Home
Fourth Year of Computer Science (2019 Course)
410255: Laboratory Practice V

Teaching Scheme	Credit	Examination Scheme
Practical: 2 Hours/Week	01	Term Work: 50 arks Practical: 50 Marks

Companion Course: Quantum Computing(410650), Deep Learning(410251)

Course Objectives:

- To understand and implement searching and sorting algorithms.
- To learn the fundamentals of GPU Computing in the CUDA environment.
- To illustrate the concepts of Artificial Intelligence/Machine Learning(AI/ML).
- To understand Hardware acceleration.
- To implement different deep learning models.

Course Outcomes:

CO1: Analyze and measure performance of sequential and parallel algorithms.
CO2: Design and Implement solutions for multicore/Distributed/parallel environment.
CO3: Identify and apply the suitable algorithms to solve AI/ML problems.
CO4: Apply the technique of Deep Neural network for implementing Linear regression andclassification.
CO5: Apply the technique of Convolution (CNN) for implementing Deep Learning models.
CO6: Design and develop Recurrent Neural Network (RNN) for prediction.

Guidelines for Instructor's Manual

Laboratory Practice V is for practical hands on for core courses High Performance Computing and Data Learning. The instructor's manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, references among others.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal may

consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, Algorithm/Database design, test cases, conclusion/analysis). Program codes with sample output of allperformed assignments are to be submitted as softcopy.

Guidelines for Laboratory /Term Work Assessment

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

Guidelines for Practical Examination

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

Guidelines for Laboratory Conduction

- List of recommended programming assignments and sample mini-projects is provided for reference.
- Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related tothe respective courses.
- Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
- Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
- Mini-project can be completed in group of 2 to 3 students.

- Software Engineering approach with proper documentation is to be strictly followed.
- Use of open source software is to be encouraged.
- Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.

Operating System recommended :- 64-bit Open source Linux or its derivative
Programming Languages: Object Oriented Languages
C++/JAVA/PYTHON/R
Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, Backend : MongoDB/MYSQL/Oracle, Database Connectivity : ODBC/JDBC

Suggested List of Laboratory Experiments/Assignments

10650: Quantum Computing

Any 4 Assignments and 1 Mini Project is Compulsory

Group 1	
1.	Analyze simple states of superposition and the effect of doing the measurement in different basis states .
2.	Build simple quantum circuits with single and two-qubit gates
3.	Learn how to use the IBM infrastructure to write quantum programs in QASM (Quantum Assembly) language.
4.	Analyze quantum circuits with entanglement
5.	Analyze the effectiveness of simple error correction scheme
Group 2	
6.	**Mini Project:** Evaluate performance enhancement of parallel Quicksort Algorithm using MPI
7.	**Mini Project:** Build an interactive web app that visualizes core quantum mechanics concepts — Bloch sphere rotation, superposition probability, and Bell state correlations — to help learners develop intuition without heavy math. Module 1: Bloch sphere: 3D interactive visualization with sliders for θ, φ angles Module 2: Superposition explorer: animate wavefunction and show measurement collapse Module 3: Bell state demonstrator: show correlation statistics for all 4 Bell states Module 4: Quiz module: test understanding of measurement outcomes
8.	**Mini Project:** Build a drag-and-drop quantum circuit designer web app where users can place quantum gates on qubits, run the circuit on a built-in statevector simulator, and visualize the quantum state and measurement probabilities. Module 1: Circuit canvas: drag-and-drop gate palette (H, X, Y, Z, S, T, CNOT, Toffoli) Module 2: Statevector engine: matrix-multiply backend in Python/NumPy Module 3: State visualization: Bloch sphere per qubit + probability bar chart Module 4: Export to Qiskit code: generate equivalent Qiskit Python code
9.	Build a mini quantum Sudoku solver for 2×2 mini-Sudoku grids using Grover's algorithm. Encode the Sudoku constraints as a quantum oracle and use amplitude amplification to find valid solutions. Module 1: Mini-Sudoku encoder: map 2×2 grid cells to qubit registers

	Module 2: Oracle construction: CNOT/Toffoli circuit for row/column/box constraints Module 3: Grover circuit: diffusion operator + oracle; auto-compute optimal iterations Module 4: Classical decoder: map measurement results back to Sudoku grid

410251: Course Code : Deep Learning

Any 3 Assignments and 1 Mini Project is Compulsory

Group 1

1.	Linear regression by using Deep Neural network: Implement Boston housing price prediction problem by Linear regression using Deep Neural network. Use Boston House price prediction dataset.
2.	**Classification using Deep neural network** (Any One from the following) 1. Multiclass classification using Deep Neural Networks: Example: Use the OCR letter recognition datasethttps://archive.ics.uci.edu/ml/datasets/letter+recognition 2. Binary classification using Deep Neural Networks Example: Classify movie reviews into positive" reviews and "negative" reviews, just based on the text content of the reviews. Use IMDB dataset
3.	Convolutional neural network (CNN) (Any One from the following) • Use any dataset of plant disease and design a plant disease detection system using CNN. • Use MNIST Fashion Dataset and create a classifier to classify fashion clothing into categories.
4.	**Recurrent neural network (RNN)** Use the Google stock prices dataset and design a time series analysis and prediction system using RNN.
Group 2	
5.	Mini Project: Human Face Recognition
6.	Mini Project: Gender and Age Detection: predict if a person is a male or female and also their age
7.	Mini Project: Colorizing Old B&W Images: color old black and white images to colorful images

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course)
410256: Laboratory Practice VI

Teaching Scheme	Credit	Examination Scheme and Marks
Practical: 02 hours/Week	01	Term Work: 50 Marks

Companion Course: Elective Courses 410252, 410253

Course Objectives:

- To understand the fundamental concepts and techniques of natural language processing (NLP)
- To understand Digital Image Processing Concepts
- To learn the fundamentals of software definednetworks
- Explore the knowledge of adaptive filtering and Multi-rate DSP
- To be familiar with the various application areas of soft computing.
- To introduce the concepts and components of Business Intelligence (BI)
- To study Quantum Algorithms and apply these to develop hybrid solutions

Course Outcomes:

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

CO1: Apply basic principles of elective subjects to problem solving and modeling.

CO2: Use tools and techniques in the area of software development to build mini projects

CO3: Design and develop applications on subjects of their choice.

CO4: Generate and manage deployment, administration & security.

Guidelines for Instructor's Manual

List of recommended programming assignments and sample mini-projects is provided for reference. Referring to these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses. Preferably there should be multiple sets of assignments/mini-project and distributed among batches of students. Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects. Mini-project can be completed in group of 2 to 3 students. Software Engineering approach with proper documentation is to be strictly followed. Use of open source software is to be encouraged. Instructor may also set one assignment or mini-project that is suitable to the respective course beyond the scope of syllabus.

Operating System recommended: - 64-bit Open source Linux or its derivative **Programming Languages**: C++/JAVA/PYTHON/R

Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, **Backend**: MongoDB/MYSQL/Oracle, Database Connectivity: ODBC/JDBC, **Additional Tools**: Octave, Matlab, WEKA,powerBI

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by students in the form of a journal. Journal may consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, Algorithm/Database design, test cases, conclusion/analysis). Program codes with sample output of all performed assignments are to be submitted as softcopy.

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

Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work is to be done based on overall performance and lab Home Faculty of Engineering Savitribai Phule Pune University

Syllabus for Fourth Year of Computer Engineering assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness reserving weightage for successful mini-project completion and related documentation.

Guidelines for Practical Examination

It is recommended to conduct examination based on Mini-Project(s) Demonstration and related skill learned. Team of 2 to 3 students may work on mini-project. During the assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation and software engineering approach followed. The supplementary and relevant questions may be asked at the time of evaluation to test the student‟s for advanced learning, understanding, effective and efficient implementation and demonstration skills. Encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising start of the student's academics.

Guidelines for Laboratory Conduction

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

PART-I 410252 : Elective V

Recommended / Sample set of assignments and mini projects for reference for four courses offered for Elective III and for four courses offered for Elective IV. Respective Student has to complete laboratory work for elective V and VI that he/she has opted.

410252(A) : Natural Language Processing

Any 4 Assignments and 1 Mini Project is Compulsory

Group 1

1.	Perform tokenization (Whitespace, Punctuation-based, Treebank, Tweet, MWE) using nltk library. Use porter stemmer and snowball stemmer for stemming. Use any technique for lemmatization. **Input / Dataset –use any sample sentence**
2	Perform bag-of-words approach (count occurrence, normalized count occurrence), tf-idf on data. Create embeddings using Word2Vec. **Dataset to be used:** https://www.kaggle.com/datasets/CooperUnion/cardataset
3	Perform text cleaning, perform lemmatization (any method), remove stop words (any method), label encoding. Create representations using TF-IDF. Save outputs. **Dataset: https://github.com/PICT-NLP/BE-NLP-Elective/blob/main/3-Preprocessing/News_dataset.pickle**
4	Create a transformer from scratch using the Pytorch library

5	Morphology is the study of the way words are built up from smaller meaning bearing units. Study and understand the concepts of morphology by the use of add delete table
6	**Mini Project (Fine tune transformers on your preferred task)** Finetune a pretrained transformer for any of the following tasks on any relevant dataset of your choice: • Neural Machine Translation • Classification • Summarization

Virual Lab:https://nlp-iiith.vlabs.ac.in/

410252(B) : Image Processing

Any 5 Assignments and 1 Mini Project is Compulsory

Group 1

Implement any five assignments from 1 to 7. Assignment no. 8 is compulsory within a group of 2 to 3 students. Programing language: Python/C/C++ using OpenCV

1.	Consider any image with size 1024*1024. Modify the image to the sizes 512*512, 256*256, 128*128, 64*64 and 32*32 using subsampling technique. Create the original image from all the above subsampled images using resampling technique. Read any image. Display the histogram, Equalized histogram, and image with equalized histogram
2	Consider any image with size 1024*1024. Modify the image to the sizes 512*512, 256*256, 128*128, 64*64 and 32*32 using subsampling technique. Create the original image from all the above subsampled images using resampling technique.
3	Read any image. Display the histogram, Equalized histogram, and image with equalized histogram
4	Read any image. Display the outputs of contrast stretching, intensity level slicing
5	Compare the results of any three edge detection algorithms on the same image dataset and do the analysis of the result.
6	Compare the result of any two image segmentation algorithm on the same image data set
7	Write a program for image compression using any three compression techniques and compare the results.

Group 2:

8	**Mini project:** Implement visual surveillance applications and detect moving objects using object detection and tracking algorithm Or Implement any medical image processing application for freely available medical image dataset

410252(C) : Software Defined Networks	
Any 3 Assignments and 1 Mini Project is Compulsory	
Group 1	
1.	Prepare setup for Mininet network emulation environment with the help of Virtualbox and Mininet. Demonstrate the basic commands in Mininet and emulate different custom network topology(Simple, Linear, and Tree).View flow tables.
2	After studying open source POX and Floodlight controller, Install controller and run custom topology using remote controller like POX and floodlight controller. Recognize inserted flows by controllers.
3	Create a SDN environment on Mininet and configure a switch to provide a firewall functionality using POX controller. Ref: https://github.com/mininet/openflow-tutorial/wiki/Create- Firewall
4	Using Mininet as an Emulator and POX controller, build your own internet router. Write simple outer with a static routing table. The router will receive raw Ethernet frames and process the packet forwarding them to correct outgoing interface. You must check the Ethernet frames are received and the forwarding logic is created so packets go to the correct interface. Ref:https://github.com/mininet/mininet/wiki/SimpleRouter
5	Emulate and manage a Data Center via a Cloud Network Controller: create a multi-rooted tree-like (Clos) topology in Mininet to emulate a data center. Implement specific SDN applications on top of the network controller in order to orchestrate multiple network tenants within a data center environment, in the context of network virtualization and management. Ref:https://opencourses.uoc.gr/courses/pluginfile.php/13576/mod_resource/content/2/exercise 5.pdf
6	Study Experiment: Study in details CloudS eeds automates IaaS using SDN and a high-performance network from Juniper SDN Framework.

410252(D) : Wireless Sensor Network	
Any 5 Assignments and 1 Mini Project is Compulsory	
Group 1	
1.	Using NS-3 or Cooja simulator, implement and compare three MAC protocols: S-MAC, T-MAC, and B-MAC on a 20-node linear topology. Measure: (a) packet delivery ratio (PDR), (b) end-to-end latency, (c) energy consumed per delivered packet. Vary traffic load (1–10 packets/s) and duty cycle (5%–30%) and plot the results.
2	Implement three localization algorithms — Centroid, DV-Hop, and APIT — in Python for a 50-node WSN with 10% anchor nodes on a 100m×100m field. Evaluate localization error (mean absolute error in metres) under varying anchor density (5%, 10%, 20%, 30%) and communication range (15m, 20m, 30m). Visualize estimated vs. actual positions.
3	Implement the LEACH clustering protocol in Python or MATLAB for a 100-node randomly deployed WSN on a 100m×100m field with a single base station. Simulate 500 rounds and record: number of alive nodes per round, residual energy distribution, and cluster-head selection frequency. Compare with static clustering and direct transmission baselines.
4	Using NS-3 or a Python-based WSN simulator, simulate three attacks on a 30-node WSN: (a) Sybil attack — one node claims multiple identities, (b) Sinkhole attack — compromised node attracts routes, (c) Hello Flood attack. Implement a simple rule-based Intrusion Detection System (IDS) to detect each attack. Measure detection rate and false positive rate
5	Design and prototype an end-to-end IoT-integrated WSN application of choice (e.g., smart greenhouse, air quality monitor, or patient health monitor). Use real or simulated sensor nodes (Raspberry Pi / Arduino / Cooja), MQTT broker for data transfer, and a cloud dashboard (ThingSpeak, Grafana, or AWS IoT). Implement a simple threshold-based or ML-based alerting rule.
6	Design and prototype an end-to-end IoT-integrated WSN application of choice (e.g., smart greenhouse, air quality monitor, or patient health monitor). Use real or simulated sensor nodes (Raspberry Pi / Arduino / Cooja), MQTT broker for data transfer, and a cloud dashboard (ThingSpeak, Grafana, or AWS IoT). Implement a simple threshold-based or ML-based alerting rule.
Group 2: Any One	
7.	Design and simulate a precision agriculture sensor network that monitors soil moisture, temperature, and humidity across a crop field. Implement LEACH-based clustering for energy efficiency and a threshold-based automated irrigation actuation rule. Integrate with a cloud dashboard via MQTT for remote monitoring and alert generation.
8.	Build a federated learning pipeline where each sensor cluster head trains a local LSTM-based anomaly detection model on time-series sensor data, and only model weights are shared with a central aggregator (FedAvg). Compare federated vs. centralised training on energy consumption and detection accuracy for a temperature anomaly detection task.

410252(E) : Open Elective	
1.	Suitable set of programming assignments/Mini-projects for open elective Opted.
PART-II 410253 : Elective VI	
410253(A) : Pattern Recognition	
Any 4 Assignments are Compulsory	
1	For face Recognition • Implemented PCA and multiclass LDA. • Using EigenFaces and FisherFaces to recognise faces in the orl faces data set.
2	Perform sentiment analysis on the IMDB movie reviews dataset
3	Perform a classification task on a dataset of modulated radio signals.
4	Perform image segmentation on the Berkley Segmentation dataset
410253(B) :Soft Computing	
Any 4 Assignments and 1 Mini Project is Compulsory	
Group 1	
1	Design an X-OR Gate with feed-forward neural network (also popularly known as a Multilayer Perceptron) classifier.
2	Symmetric and Asymmetric implementation of Particle Swarm Optimization for Traveling Salesman Problem.
3	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.
4	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.

5	Implement genetic algorithm for benchmark function (eg. Square, Rosenbrock function etc) Initialize the population from the Standard Normal Distribution. Evaluate the fitness of all its individuals. Then you will do multiple generation of a genetic algorithm. A generation consists of applying selection, crossover, mutation, and replacement. Use: • Tournament selection without replacement with tournament size s • One point crossover with probability Pc • bit-flip mutation with probability Pm • use full replacement strategy

Group 2:	
6	Mini Project - Create a small hybrid system for solving a chosen problem by following the given steps below. 1. Explain on one page the main characteristics of hybrid systems. 2. For the task chosen from the list below, create a multimodular block diagram of a possible solution to the problem. 3. Choose appropriate techniques for solving each sub problem represented as a module. What alternatives are there for each of them? 4. Create subsystems for solving each of the sub problems. Compile the whole hybrid system. 5. Make experiments with the hybrid system and validate the results. A) Handwritten digits recognition B) Bank loan approval decision-making system C) Stock market prediction D) Unemployment prediction E) Spoken words recognition, for example, "on"/"off"; "yes"/"no"; "stop"/ "go." F) Loan approval
410253(C): Business Intelligence	
Any 5 Assignments and 1 Mini Project is Compulsory	
1	Import the legacy data from different sources such as (Excel , SqlServer, 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 Sqlserver.
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	Business Intelligence 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.

410253(D) : Reinforcement Learning

Any 5 assignments are compulsory and 1 Mini Project.

1	Implement the k-armed bandit problem in Python with at least four action-selection strategies: ε-greedy, optimistic initial values, UCB, and gradient bandit. Compare cumulative rewards and optimal action percentages over 2000 time steps on a 10-armed stationary and non-stationary testbed. Plot and interpret learning curves.
2	Model three real-world scenarios as MDPs: (a) an autonomous traffic signal controller, (b) a student exam preparation schedule, and (c) a warehouse robot navigation. For each, define state space, action space, transition probabilities, reward function, and discount factor. Derive and solve Bellman optimality equations for a simplified (4-state) version of one scenario by hand.
3	Implement Policy Iteration and Value Iteration from scratch (no RL libraries) on a configurable Grid World environment (5×5 and 10×10). Compare convergence speed (iterations to convergence), computational cost, and final policy quality. Introduce stochastic transitions (slip probability = 0.1) and analyze the impact on the optimal policy.
4	Using OpenAI Gym's Blackjack-v1 environment, implement: (a) First-visit MC prediction to estimate the value function under a fixed policy, (b) MC Control with Exploring Starts to derive an optimal policy, and (c) Off-policy MC with importance sampling. Visualize the 3D value function surface (player sum × dealer card) before and after optimization.
5	Implement SARSA (on-policy) and Q-Learning (off-policy) on the Cliff-Walking environment (OpenAI Gym). Record: (a) episode rewards during training, (b) the learned policy paths, and (c) effect of varying ε and α hyperparameters. Extend to Expected SARSA and double Q-learning to observe maximization bias. Provide a rigorous comparison and explain the safe vs. optimal path trade-off
6	Apply semi-gradient SARSA with tile-coding feature construction to solve the Mountain Car problem (Gym: MountainCar-v0). Implement tile coding from scratch (no scikit-learn wrappers). Experiment with the number of tilings (4, 8, 16) and tile resolution. Compare learning curves with a hand-crafted polynomial feature baseline. Analyze the deadly triad risk when using function approximation with off-policy learning.
7	**Mini Project:** Implement from scratch using PyTorch: (a) REINFORCE (Monte Carlo Policy Gradient), (b) REINFORCE with baseline (value function as baseline), and (c) one-step Actor-Critic. Train all three on CartPole-v1 (OpenAI Gym). Compare sample efficiency, variance in returns, and training stability. Plot policy entropy over episodes to observe convergence behavior.
8	**Mini Project:** Implement the full DQN pipeline (convolutional neural network, experience replay buffer, target network) using PyTorch on the CartPole-v1 or LunarLander-v2 environment. Extend to Double DQN and compare performance. Ablate the contribution of (a) experience replay and (b) target network by training variants with each disabled. Present findings in a demo video and technical report.

410253(E) : Open Elective

1.	Suitable set of programming assignments/Mini-projects for open elective Opted.

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

Savitribai Phule Pune University
Fourth Year of Computer Science (2019 Course) 410256: Project Work Stage II

Teaching Scheme:	Credit	Examination Scheme:
TH: 06 Hours/Week	06	Term work: 100 Marks Presentation:50Marks

Prerequisite Courses:

Companion Course:

Course Objectives:

- To follow SDLC meticulously and meet the objectives of proposed work
- To test rigorously before deployment of system
- To validate the work undertaken
- To consolidate the work as furnished report

Course Outcomes:

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

CO1: Show evidence of independent investigation

CO2: Critically analyze the results and their interpretation.

CO3: Report and present the original results in an orderly way and placing the open questions in the rightperspective.

CO4: Link techniques and results from literature as well as actual research and future research lines withthe research.

CO5: Appreciate practical implications and constraints of the specialist subject

Guidelines

In Project Work Stage–II, the student shall complete the remaining project work which consists of Selection of Technology and Tools, Installations, UML implementations, testing, Results, performance discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems and comparative analysis and validation of results and conclusions. The student shall prepare and submit the report of Project work in standard format for satisfactory completion of the work that is the duly certified by the concerned guide and head of the Department/Institute

Follow guidelines and formats as mentioned in Project Workbook recommended by Board of Studies

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

Criteria

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

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

- 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
AC8-I	Usability Engineering
AC8- II	Conversational Interface
AC8-III	Social Media and Analytics
AC8-IV	MOCC-Learn New Skills
AC8-V	Emotional Intelligence

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AC8 – I: Usability Engineering

In this course you will have a hands-on experience with usability evaluation and user-centered design. This course will not help to learn how to implement user interfaces, but rather how to design based on the needs of users, which you will determine, and learn how toevaluate your designs rigorously. This help in knowing more about the usability; human computer interaction, the psychological aspects of computing, evaluation.

Course Objectives:

- To understand the human centered design process and usability engineering process andtheir roles in system design and development.
- To know usability design guidelines, their foundations, assumptions, advantages, and weaknesses
- Understand the user interface based on analysis of human needs and prepare a prototype system

Course Outcome:

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

CO1: Describe the human centered design process and usability engineering process and theirroles in system design and development.
CO2: Discuss usability design guidelines, their foundations, assumptions, advantages, andweaknesses.
CO3: Design a user interface based on analysis of human needs and prepare a prototype system.
CO4: Assess user interfaces using different usability engineering techniques.
CO5: Present the design decisions

Course Contents:

1. What Is Usability?: Usability and Other Considerations, Definition of Usability, Example: Measuring the Usability of Icons, Usability Trade-Offs, Categories of Users and Individual User Differences
2. Usability in Software Development : The Emergence of Usability, Human ComputerInteraction, Usability Engineering
3. The usability Engineering Lifecycle: Requirement Analysis, Design, Testing, Development
4. Usability Assessment Methods beyond Testing
5. International User Interfaces

Books:

1. Mary Beth Rosson, John Millar Carroll, “Usability Engineering: Scenario- based Development of Human- Computer Interaction”
2. Jakob Nielsen, “Usability Engineering”
1. Deborah J. Mayhew, “ The usability engineering lifecycle”

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AC8 – II: Conversational Interfaces

Effective information security at the enterprise level requires participation, planning, and practice. It is an ongoing effort that requires management and staff to work together from the same script. Fortunately, the information security community has developed a variety of resources, methods, and best practices to help modern enterprises address the challenge. Unfortunately, employing these tools demands a high degree of commitment, understanding, and skill attributes that must be sustained through constant awareness and training.

Course Objectives:

- To understand the basics of conversation
- To know the interactive environments for conversational skills
- To acquaint with the speech to text and text to speech techniques

Course Outcome:

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

CO1: Develop an effective interface for conversation

CO2: Explore advanced concepts in user interface

Course Contents:

1. **Introduction to Conversational Interface:** Preliminaries, Developing a speech based Conversational Interface, Conversational Interface and devices.
2. **A technology of Conversation:** Introduction, Conversation as Action, The structure of Conversation, The language of Conversation.
3. **Developing a Speech-Based Conversational Interface:** Implementing Text to Speech: Text Analysis, Wave Synthesis, Implementing Speech Recognition: Language Model, Acoustic Model, Decoding. Speech Synthesis Markup Language.
4. **Advanced voice user interface design**

Books:

1. Cathy Pearl, “Designing Voice User Interfaces: Principles of Conversational Experiences”
2. Michael McTear, ZoraidaCallejas, David Griol, “ The Conversational Interface: Talking to Smart Devices”
3. Martin Mitrevski, “Developing Conversational Interfaces for iOS: Add Responsive Voice Control”
4. SriniJanarthanam, “ Hands-On Chatbots and Conversational UI Development: Build chatbots”

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AC8–III: Social Media And Analytics

Prerequisite : Knowledge of Social Media Networking.

Course Objectives:

- Get strategic understanding of Digital Marketing and Social Media Marketing.
- Understand how to use it for branding and sales.
- Understand its advantages& limitations.
- Become familiar with Best Practices, Tools &Technologies.
- Blend digital and social marketing with offline marketing.
- Plan and manage digital marketing budget.
- Manage Reporting & Tracking Metrics.
- Understand the future of Digital Marketing and prepare for it.

Course Outcome:

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

CO1: Develop a far deeper understanding of the changing digital land scape.

CO2: Identify some of the latest digital marketing trends and skill sets needed for today's marketer.

CO3: Successful planning, prediction, and management of digital marketing campaigns

CO4: Assessuserinterfacesusingdifferentusabilityengineeringtechniques.

CO5: Implement smart management of different digital assets for marketing needs.

CO6: Assess digital marketing as a long term career opportunity.

Course Contents:

1. Digital Marketing, History of Digital Marketing, Importance of Digital Marketing, Effective use of Digital Marketing, Effects of wrong Digital Marketing, Digital Marketing to develop brands, Digital Marketing for sales, Digital Marketing for product and service development.
2. Techniques for effective Email Marketing and pitfalls, Various online email marketing platforms such as Campaign Monitor and Mail Chimp, Web content, web usability, navigation and design, Bookmarking and News Aggregators, Really Simple Syndication (RSS),Blogging, Live Chat, User Generated Content (Wikipediaetc),Multi-media - Video (Video Streaming, YouTube etc),Multi-media - Audio & Podcasting (iTunes etc),Multi-media - Photos/Images (Flickr etc),Google Alerts and Giga Alert (Brand, product and service monitoring online),Crowd sourcing,Virtual Worlds.
3. Search Engine Optimization (SEO), Search Engine Optimization (SEO) tips and techniques, Google Adwords, Google various applications such as 'Google Analytics', Maps, Places etc to enhance a brand's products, services and operations.
4. Fcebook&LinkedInandotherSocialMediaforarealmarketing,UtilizingFacebookandLinkedIn'sAdvertising functionality and Applications, Brand reputation management techniques, Systems for 'buzzmonitoring'forbrands,productsandservices,EffectivePublicRelations(PR)onlineandbusinessdevelopment.

References:

1. Vandana Ahuja, “Digital Marketing”, OxfordPress, ISBN:9780199455447,1st Edition.
2. Wiley, Jeanniey, Mullen, David Daniels, David Gilmour, “Email Marketing: An Houra Day, -ISBN:978-0-470-38673-6,1st Edition.

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AC8 – IV: MOOC-learn New Skill

This course aims to create awareness among the students regarding various courses available under MOOC and learn new skills through these courses.

Course Objectives:

- To promote interactive user forums to support community interactions among students, professors, and experts
- To promote learn additional skills anytime and anywhere
- To enhance teaching and learning on campus and online

Course Outcomes:

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

CO1: To acquire additional knowledge and skill.

About Course

MOOCs (Massive Open Online Courses) provide affordable and flexible way to learn new skills, pursue lifelong interests and deliver quality educational experiences at scale. Whether you'reinterested in learning for yourself, advancing your career or leveraging online courses to educate your workforce, SWYAM, NPTEL, edx or similar ones can help. World's largest SWAYAM MOOCs, a new paradigm of education for anyone, anywhere, anytime, as per your convenience, aimed to provide digital education free of cost and to facilitate hosting of all the interactive courses prepared by the best more than 1000 specially chosen faculty and teachers in the country. SWAYAM MOOCs enhances active learning for improving lifelong learning skills by providing easy access to global resources.

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effortis to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy. This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses.

The courses hosted on SWAYAM is generally in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology. In order to ensure best quality content are produced and delivered, seven National Coordinators have been appointed: They are NPTEL for engineering and UGC for post-graduation education.

Guidelines:

Instructors are requested to promote students to opt for courses (not opted earlier) with proper mentoring. The departments will take care of providing necessary infrastructural and facilities for the learners.

References:

4. https://swayam.gov.in/
5. https://onlinecourses.nptel.ac.in/
6. https://www.edx.org

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AC8 – V: Emotional Intelligence

This Emotional Intelligence (EI) training course will focus on the five core competencies of emotional intelligence: self-awareness, self-regulation, motivation, empathy and interpersonal skills. Participants will learn to develop and implement these to enhance their relationships in work and life by increasing their understanding of social and emotional behaviors, and learning how to adapt and manage their responses to particular situations. Various models of emotional intelligence
will be covered.

Course Objectives:

- To develop an awareness of EI models
- To recognize the benefits of EI
- To understand how you use emotion to facilitate thought and behavior
- To know and utilize the difference between reaction and considered response

Course Outcomes:

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

CO1: Expand your knowledge of emotional patterns in yourself and others
CO2: Discover how you can manage your emotions, and positively influence yourself and others
CO3: Build more effective relationships with people at work and at home
CO4: Positively influence and motivate colleagues, team members, managers
CO5: Increase the leadership effectiveness by creating an atmosphere that engages others

Course Contents

1. **Introduction to Emotional Intelligence (EI) :** Emotional Intelligence and various EI models, The EQ competencies of self-awareness, self-regulation, motivation, empathy, and interpersonal skills, Understand EQ and its importance in life and the workplace
2. **Know and manage your emotions:** emotions, The different levels of emotional awareness, Increase your emotional knowledge of yourself, Recognize „negative" and „positive" emotions. The relationship between emotions, thought and behavior, Discover the importance of values, The impact of not managing and processing „negative" emotions, Techniques to manage your emotions in challenging situations
3. **Recognize emotions in others :**The universality of emotional expression, Learn tools to enhance your ability to recognize and appropriately respond to others' emotions, Perceiving emotions accurately in others to build empathy
4. **Relate to others**: Applying EI in the workplace, the role of empathy and trust in relationships,Increase your ability to create effective working relationships with others (peers, subordinates, managers, clients, Find out how to deal with conflict, Tools to lead, motivate others and create a high performing team.

Books:

1. Daniel Goleman, "Emotional Intelligence – Why It Matters More Than IQ," , BantamBooks, ISBN-10: 055338371X13: 978-0553383713
2. Steven Stein , "The EQ Edge" , Jossey-Bass, ISBN : 978-0-470-68161-9
3. Drew Bird , "The Leader"s Guide to Emotional Intelligence" , ISBN: 9781535176002

Acknowledgement

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