Curriculum
for

Final Year
of
Computer Science and Design
(2021 Course)

(With effect from 2024-25)

Faculty of Science and Technology

Savitribai Phule Pune University, Maharashtra, India

Final Year of Computer Science and Design
(2021 Course)
(With effect from 2024-25)

Prologue

It is with great pleasure and honour to share the syllabi for Fourth Year of Computer Science and Design (2021 Course) on behalf of Board of Studies, Computer Engineering. We, members of BoS are giving our best to streamline the processes and curricula design.

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

Syllabus revision is materialized with sincere efforts, active participation, expert opinions and suggestions from domain professionals. Sincere efforts have been put by members of BoS, teachers, alumni, industry experts in framing the draft with guidelines and recommendations.

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

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

Thanks,

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

links for First Year, Second Year and Third Year Computer Science & Design Curriculum:

1. **http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/Rules%20and%20Regulations%20F.E.%202019%20Patt_10.012020.pdf**
2. **http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202019/First%20Year%20Engineering%202019%20Patt.Syllabus_05.072019.pdf**
3. **http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2022/SE%20CSD%20Syllabus_31032023.pdf**
4. **http://collegecirculars.unipune.ac.in/sites/documents/Syllabus2023/TE%20Computer%20Science%20and%20Design%20Syllabus_03082023.pdf**

Savitribai Phule Pune University

Fourth Year of Computer Science and Design (2021 Course)

(With effect from Academic Year 2024-25)

Table of Contents

Savitribai Phule Pune University
Bachelor of Computer Science and Design

Program Outcomes (POs)

Learners are expected to know and be able to–

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

Program Specific Outcomes (PSO)

PSO1	**Professional Skills**-The ability to understand, analyse 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.

Savitribai Phule Pune University

Fourth Year of Computer Science and Design(2021Course)

(With effect from Academic Year 2024-25)

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\PR	Total	Lecture	Practical	Tutorial	Total
418241	Computer Vision	03	-	-	30	70	-	-	-	100	3	-	-	3
418242	Deep learning	03	-	-	30	70	-	-	-	100	3	-	-	3
418243	Game Design and Development	03	-	-	30	70	-	-	-	100	3	-	-	3
418244	Elective III	03	-	-	30	70	-	-	-	100	3	-	-	3
418245	Elective IV	03	-	-	30	70	-	-	-	100	3	-	-	3
418246	Laboratory Practice III	-	04	-	-	-	50	50	-	100	-	2	-	2
418247	Laboratory Practice IV	-	02	-	-	-	25	-	25	50	-	1	-	1
418248	Project Stage I	-	02	-	-	-	50	-	-	50	-	2	-	2
										Total Credit	**15**	**05**	**-**	**20**
	Total	**15**	**08**	**-**	**150**	**350**	**125**	**50**	**25**	**700**	**15**	**05**	**-**	**20**
418249	Audit Course 7										**Grade**			

Elective III	**Elective IV**
(A) Object Oriented Modelling and Design (B) Software Testing and Quality Assurance (C) Blockchain Technology (D) Information Retrieval	(A) Natural Language Processing (B) Software Development for Portable devices (C) Compiler Design (D) Advanced UI/UX Design
Laboratory Practice III: Laboratory assignments Courses- 418241, 418242,418243	**Laboratory Practice IV:** Laboratory assignments Courses- 418244, 418245

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

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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\PR	Total	Lecture	Practical	Tutorial	Total
418250	Information & Cyber Security	03	-	-	30	70	-	-	-	100	3	-	-	3
418251	Generative AI	03	-	-	30	70	-	-	-	100	3	-	-	3
418252	Elective V	03	-	-	30	70	-	-	-	100	3	-	-	3
418253	Elective VI	03	-	-	30	70	-	-	-	100	3	-	-	3
418254	Laboratory Practice V	-	02	-	-	-	50	50	-	100		01	-	1
418255	Laboratory Practice VI	-	02	-	-	-	25	-	25	50	-	01	-	1
418256	Project Stage II	-	06	-	-	-	100	-	50	150	-	06	-	6
										Total Credit	**12**	**08**	**-**	**20**
	Total	**12**	**10**	**-**	**120**	**280**	**175**	**50**	**75**	**700**	**12**	**08**	**-**	**20**
418257	Audit Course 8										**Grade**			

Elective V	**Elective VI**
(A) Computational Intelligence (B) Software Defined Networks (C) High Performance Computing (D) DevOps	(A) Data Visualization (B) Optimization Algorithm (C) GPU Programming and Architecture Design (D) Mobile Computing
Laboratory Practice V: Laboratory assignments Courses- 418250,418251	**Laboratory Practice VI** Laboratory assignments Courses- 418252,418253

Audit Course 8(AC8) Options:
AC8- I Conversational Interfaces
AC8- II social media and Analytics
AC8- III MOOC- Learn New Skills
AC8- IV 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 (COs)** though highly rely on the contents of the course, many a times are generic and bundled. The **Course Objectives**, **Course Outcomes** and **CO-PO mappings matrix justifies** the motives, accomplishment and prospect behind learning the course. The Course Objectives, Course Outcomes and CO-PO Mapping Matrix are provided for reference and these are indicative only. The course instructor may modify them as per his or her perspective.
2. **CO and PO Mapping Matrix** (Course Objectives and Program Outcomes) attainment mapping matrix at end of course contents, indicates the correlation levels of 3, 2, 1 and '- '. The notation of 3, 2 and 1 denotes substantially (high), moderately (medium) and slightly (low). The mark '- 'indicates that there is no correlation between CO and PO.
3. For each course, contents are divided into **Six Units**- I, II, III, IV, V and VI

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

4. For each unit contents, the content attainment mapping is indicated with Course Outcome(s). Instructor may revise the same as per their viewpoint.
5. For laboratory courses, set of suggested assignments is provided for reference. Laboratory Instructors may design suitable set of assignments for respective course at their level. Beyond curriculum assignments and mini-project may be included as the part of laboratory work. Inclusion of it will be the value addition for the students and it will satisfy the intellectuals within the group of the learners and will add to the perspective of the learners.
6. For each laboratory assignment, it is essential for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorial may be as per guidelines of authority.
7. For each course, irrespective of the examination head, the instructor should motivate students to read articles/research papers related to recent development and invention in the field.
8. For laboratory, instructions have been included about the conduction and assessment of laboratory work. These guidelines are to be strictly followed.
9. **Term Work** –Term work is continuous assessment that evaluates a student's progress throughout the semester. Term work assessment criteria specify the standards that must be met and the evidence that will be gathered to demonstrate the achievement of course outcomes. Categorical assessment criteria for the term work should establish unambiguous standards of achievement for each course outcome. They should describe what the learner is expected to perform in the laboratories or on the fields to show that the course outcomes have been achieved.

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

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

Abbreviations

TW: Term Work	**TH: Theory**	**PR: Practical**
OR: Oral	**SEM: Semester**	

SEMESTER VII

Savitribai Phule Pune University, Pune
Fourth Year of Computer Science & Design (2021Course)
418241: Computer Vision

Teaching Scheme	Credit Scheme	Examination Scheme
Theory (TH): 3 hrs/week	03 Credits	Mid_Semester: 30 Marks End_Semester: 70 Marks

Prerequisite Courses:

1. Students should know vectors, linear algebra (i.e., matrix operations, solution of linear equations).
2. Programming language (e.g., C++, Python etc).

Companion Course : Laboratory Practice III(418246)

Course Objectives:

1. To understand Human and computer vision.
2. To understand Low level image processing
3. To study image segmentation and feature representation
4. To study image understanding strategies and 3D vision
5. To understand Dynamic Scene Analysis

Course Outcomes:

By the end of the course, students should be able to -

CO1. Understand and apply the principles of image formation, representation, and processing in computer vision systems
CO2. Understand Low Level Image Processing Tasks
CO3. Apply image segmentation techniques and feature representation methods
CO4. Understand various object recognition techniques.
CO5. Implement and evaluate advanced image understanding and 3D vision techniques
CO6. Understand Dynamic Scene Analysis

COURSE CONTENTS

Unit I	Introduction to Computer Vision	7 Hours

Introduction: Human Vision Vs Computer Vision, Limitations of Human Vision System, Types of Computer Vision, Computer Vision Pipeline, History of Computer Vision. Computer Vision Applications: object detection, Recognition, Surveillance etc.,

Image formation and Representation: Cameras: Pinhole cameras, cameras with lens, Human Eye, Geometric Camera Models: Elements of Analytical Euclidian Geometry, Camera Parameters and Perspective Projections, Radiometry: measuring light Sources, shadows, and shading,

Digital Image Processing: Components, Elements of visual perception, Image Sensing and Acquisition, Image Sampling and Quantization, Relationships between pixels, different Color Models, Image Types

Mapping of Course Outcomes for Unit I	CO1

Unit II	Low Level Computer Vision	7 Hours

Low Level Image Processing: Image filtering, 2D Convolution, smoothing, sharpening Spatial and frequency domain filtering, Histogram processing (equalization, matching) Edge detection (Sobel, Canny), edge in multi spectral image, other local pre-processing operators, line, and corner detection.

Introduction to Open CV, Tools to Open and Display Images using Python or Eclipse C/C++

Mapping of Course Outcomes for Unit II	CO2

Unit III	Segmentation and Feature representation	7 Hours

Image Segmentation: Thresholding techniques Region-based segmentation (region growing, splitting and merging) Clustering-based segmentation (k-mean), Edge-based segmentation, Graph based segmentation.

Color and Texture Features, Shape Feature representation: Region identification, contour- based shape representation and description, region-based shape representation and Description, shape classes

Mapping of Course Outcomes	**CO3**

Unit IV	**Object Recognition**	**7 Hours**

Knowledge representation, review of statistical object recognition, Bays classifier, KNN classifier, hierarchical and non-hierarchical approach, clustering syntactic object recognition, recognition as a graph matching

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

Unit V	**Image Understanding and 3D vision**	**7 Hours**

Image understanding control strategies: Parallel and serial processing control, Hierarchical control Bottom-up control , Model-based control, ,Combined control, Non-hierarchical control, Active appearance models ,Semantic image segmentation and understanding

3D Vision : Methods for 3D vision, projection schemes, shape from shading, photometric stereo, shape from texture, shape from focus, active range finding, surface representations, point-based representation, volumetric representations, 3D object recognition, 3D reconstruction

Mapping of Course Outcomes for Unit V	**CO5**

Unit VI	**Motion Analysis**	**6 Hours**

Dynamic Scene Analysis, Estimating motion vectors using sequential search algorithm, logarithmic search algorithm, and hierarchical search, motion analysis, differential motion analysis methods, trajectory detection, optical flow analysis based on correspondence of interest points, Kalman filters

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

Textbooks:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, 4th Edition, Cengage Learning, USA, 2014
2. Forsyth and Ponce, “Computer Vision: A modern Approach ” –PHI.
3. R. Szeliski, “Computer vision: algorithms and applications”, ISSN 1868-095X, 2nd Edition, Springer Nature Switzerland AG, 2022

Reference Books:

1. R. Davies, “Computer & Machine Vision”, Fourth Edition, Academic Press, 2012.
2. Mark Nixon and Alberto S. Aquado, “Feature Extraction & Image Processing for Computer Vision” Third Edition, Academic Press, 2012.
3. Simon J. D. Prince, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press,2012.
4. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, 3rdEdition, Pearson, ISBN:

Online references:

1. **http://kercd.free.fr/linksKCD.html**
2. **http://www.cs.ubc.ca/spider/lowe/vision.html**
3. **http://www.visionscience.com/**
4. **OpenCV - Open Computer Vision Library**
5. **https: //open cv.org /open cv -free-course /**

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science & Design (2021Course)
418242: Deep Learning

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

Prerequisite Courses: Artificial Intelligence (318251)

Companion Course: Laboratory Practice III (418246)

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 under fitting, 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 Tensor FLow,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		
#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	**Recurrent Neural Network (RNN)**	**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, CO5	
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**	CO6	

Learning Resources

Text Books:

1. Goodfellow, I., Bengio, Y. Courville, A, –"Deep Learning", MIT Press, 2016.
2. Josh Patterson & Adam Gibson, –"Deep Learning", O'Reilly, 2017, ISBN: 9781491914250
3. Charu Agarwal,"Neural Networks and deep learning", Springer 2023, ISBN:978-3-031-29642-3
4. Nikhil Buduma, –"Fundamentals of Deep Learning", O'Reilly, ISBN: 9781492082187

Reference Books:

1. Richard S. Sutton and Andrew G. Barto,"Reinforcement Learning: An Introduction",Second edition. MIT Press. ISBN 0262039249
2. SethWeidman,,"Deep Learning from Scratch: Building with Python from First Principles",O'Reily, ISBN:978-93-5213-902-6
3. Francois Duval, –Deep Learning for Beginners, Practical Guide with Python and Tensorflow, CreateSpace Independent Publishing Platform, 2017, ISBN 1982027177, 9781982027179

e-Books :

1. 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 & Design (2021Course)

418243: Game Design and Development

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory: 03 hrs / week	**03**	**InSem Exam: 30 Marks** **EndSem Exam: 70 Marks**

Prerequisite Courses: - Design Thinking (218256), Object Oriented Programming (210247)

Companion Courses: Laboratory Practice III (418246)

Course Objectives:

- To understand gaming fundamentals
- To apply prototyping skills
- To analyze and evaluate game programming concepts
- To identify input, sound, and physics systems
- To describe game testing strategy
- To learn to manage game development projects efficiently and proficiently documenting their ideas and plans.

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

	Course Outcomes
CO1	Explain basic principles of game design
CO2	Choose and apply prototyping methods
CO3	Illustrate the elements of game programming
CO4	Identify input, sound, and physics associated with the gaming environment
CO5	Explain game testing strategies
CO6	Demonstrate a comprehensive understanding of the game development lifecycle process

COURSE CONTENTS

Unit I	**Introduction to Game Design**	**(06 hrs)**	**CO1**

Introduction to gaming: History of Video games, Gaming Platforms and Player Modes, Ludology, Common Frameworks for Ludology – MDA; Formal, Dramatic, and Dynamic Elements; Elemental Tetrad, Designer centric & Player centric design goals, Game Genres, Player motivations Story & Character development, Guiding the Player, Creating gaming experience Level Design: Structure, Time, Space.

Unit II	**Game Prototyping**	**(06 hrs)**	**CO2**

The Inscribed Layer, The Dynamic Layer, The Cultural Layer. The Responsibility of the Designer. The Benefits of Paper Prototypes, Paper Prototyping Tools, Paper Prototyping for Interfaces
Game Concept: 2D Adventure Game Level, Prototyping New Traversal Mechanics, Playtesting.

Unit III	**Game Programming**	**(06hrs)**	**CO3**

Game Development vs Game Design, Game Programming: Evolution of Video Game Programming, The Game Loop, Time and Games, Game Objects. 2D Graphics: 2D Rendering Foundations, Sprites, Scrolling, Tile Map. 3D Graphics: Basics, Coordinate Spaces, Lighting and Shading, Visibility, World Transform.

Unit IV	**Input, Sound, Physics and Cameras**	**(06hrs)**	**CO4**

Input: Input Devices, Event-Based Input Systems, Mobile Input. Sound: Basic Sound, 3D Sound, Digital Signal Processing. Physics: Planes, Rays, and Line Segments, Collision Geometry, Collision Detection, Physics-Based Movement, Physics Middleware. Cameras: Types of Cameras, Perspective Projections, Camera Implementations, Camera Support Algorithms.

Unit V	**Game Testing**	**(06hrs)**	**CO5**

Game Testing: Why Playtest?, Being a Great Play tester Yourself, The Circles of Play testers, Methods of Playtesting, Other Important Types of Testing.

Unit VI	**Production & Management: developing the process**	**(06hrs)**	**CO6**

Development Phases : Concepts, Pre-Production, Prototype, Production, Alpha, Beta, Gold, Post Production

Management: Iterative Development, common mistakes, Recovery from mistakes, Effective management

Game Documentation : Concept ,Game Proposal, Game Design Document, Technical design document ,Project plan, Test plan

Text Books

1. Jeannie Novak, “Game Development Essentials”, 3rd edition, Cengage Learning
2. Jeremy Gibson Bond, “Introduction to Game Design, Prototyping, and Development - From Concept to Playable Game with Unity and C#”, 2nd edition, Pearson Publication

Reference Books

1. Jesse Schell, “The Art of Game Designing - A Book of Lenses”, Morgan Kaufmann Publishers.
2. Sanjay Madhav, “Game Programming Algorithms and Techniques: A Platform-Agnostic Approach”, Addison-Wesley Professional, ISBN: 9780133463200, 2013

@The CO-PO Mapping Matrix

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	2	2	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	-	2
CO5	3	2	-	-	-	-	-	-	-	-	-	2
CO6	3	2										2

Savitribai Phule Pune University
Fourth Year of Computer Science & Design (2021Course)
Elective III (A) 418244: Object Oriented Modelling 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 & Project Management (318241)

Companion Course: Laboratory Practice IV (418247)

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-II**	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 a system in to sub-systems; Identifying concurrency; Allocation of sub-systems; Management of data storage; Handling global resources; Choosing a software control strategy; Handling boundary conditions; Setting the trade-off priorities; Common architectural styles; Architecture of the ATM system as the example

#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; Pattern description Communication Patterns: Forwarder-Receiver; Client-Dispatcher-Server; Publisher-Subscriber.

Management Patterns: Command processor; View handler. Idioms: Introduction; what can idioms provide? Idioms and style; Where to find idioms; Counted Pointer example

#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 Modelling and Design with UML‖, 2nd 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. ObjectOrientedModelingandDesign- 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 & Design (2021Course)
Elective III (B) 418244: Software Testing and Quality Assurance

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

Prerequisite Courses: Software Engineering and Project Management (318241)

Companion Course: Laboratory Practice IV (418247)

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.

***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 & amp; Issues. Software Quality, Quality Management Importance, Quality Best practices.

#Exemplar/CaseStudies	Online Recommendation System
*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-

#Exemplar/Case Studies	Case Study: Decision Table Testing (transferring money online to an account which is already added and approved.)
*Mapping of Course Outcomes for Unit III	**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 of Quality Management.

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

#Exemplar/Case Studies	1. Case Study #1 – Android Application Acceptance Test Suite 2. Case Study #2 – API Acceptance Test Suite Link - Software Quality Assurance Case Studies- BetaBreakers
*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 Testing framework. **2.** Case Study: (PDF) Automated Software Testing—A Case Study
***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 Academic Curriculum. 2 Case study: Evaluation of an Automated Testing Framework: A Case 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&ca
2. Naresh Chauhan, ―Software Testing Principles and Practice". https://pdfcoffee.com/download/se-4-pdf-

MOOC Courses Links:

- https://nptel.ac.in/courses/106105150
- NPTEL:NOC:SoftwareTesting(2017)(ComputerScienceandEngineering) (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 & Design (2021Course)
Elective III (C) 418244: Blockchain Technology

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

Prerequisite Courses: Computer Networks (218255)

Companion Course: Laboratory Practice IV (418247)

Course Objectives:

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

Course Outcomes:

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

Course Contents

Unit I	Mathematical Foundation for Blockchain	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	Review of Traditional Computer Architecture
*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/Case Studies	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	
***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: A Beginner's Guide to Building Blockchain Solutions",2018
2. Chris Dannen, "Introducing Ethereum and Solidity", Foundations of Crypto currency and Blockchain Programming for Beginners
3. Daniel Drescher, "Blockchain Basics", A Non -Technical Introduction in 25Steps.

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 & Application https://nptel.ac.in/courses/106/104/106104220/
2. NPTEL Course on 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	PO 11	PO 12
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 & Design (2021Course)
Elective III (D) 418244: Information Retrieval

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

Prerequisite Courses: Database Systems Design (318243)

Companion Course: Laboratory Practice IV (418247)

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 analyze the 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 The Causes And Solutions To The Problems of Information Retrieval Methods By The Library.
*Mapping of Course Outcomes for Unit-I	CO1

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 Query Processing, 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, Symbol wise Text Compression **Compressing Postings Lists:** Nonparametric Gap Compression, Parametric Gap Compression, Context-Aware Compression Methods, Index Compression for High Query Performance, Compression Effectiveness, Decoding Performance, Document Reordering. **Dynamic Inverted Indices:** Incremental Index Updates, Contiguous Inverted Lists, Non-contiguous 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, Passage Retrieval and Ranking **Categorization and Filtering:** Detailed Examples, Classification, Linear, Similarity- Based, Probabilistic Classifiers Generalized Linear Models. Information-Theoretic Model.

#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**	CO4

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, Beautiful Soup

#Exemplar/Case Studies	Study of Google Map / Facebook information retrieval
***Mapping of Course Outcomes for Unit VI**	CO5, CO6

Learning Resources

Text Books:

1. S. Buttcher, C. Clarke and G. Cormack, ‐Information Retrieval: Implementing and Evaluating Search Engines‖ MIT Press, 2010, ISBN: 0-408-70929-4.
2. C. Manning, P. Raghavan, and H. Schütze, ‐Introduction to Information Retrieval‖, Cambridge University Press, 2008, -13: 9780521865715
3. Ricardo Baeza , Yates and Berthier Ribeiro Neto, ‐Modern Information Retrieval: The Concepts and Technology behind Search‖, 2nd Edition, ACM Press Books 2011.

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

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 & Design (2021Course)
Elective IV (A) 418245: Natural Language Processing

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

Prerequisite Courses: Discrete Mathematics (210241), Theory of Computation (318242)

Companion Course: Laboratory Practice IV (418247)

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/CaseStudies	Why English is not a regular language: http://cs.haifa.ac.il/~shuly/teaching/08/nlp/complexity.pdf#page=20
*Mapping of Outcomes for	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/CaseStud	Study of Stanford Parser and POS Tagger https://nlp.stanford.edu/software/lex-parser.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, A press Publication ISBN: 9781484223871
3. Alexander Clark, Chris Fox, and Shalom Lappin, ‒The Handbook of Computational Linguistics and Natural Language Processing‖, Wiley Blackwell Publications

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 & Design (2021Course)
Elective IV (B) 418245: Software Development for Portable Devices

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

Prerequisites Courses: Object Oriented Programming (210243), Computer Network (218255)

Companion Course: Laboratory Practice IV (418247)

Course Objectives:

- To introduce the fundamentals of software development for portable devices
- To understand android application architecture, its components, device discovery and communication in portable devices
- To acquaint with the use of various hardware sensors (location etc.) and software services (e.g., notifications) on android devices
- To understand the GoogleFit platform for portable devices
- To enable students to continue their studies in the real-world application and future use of portable devices

Course Outcomes:

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

CO1: Differentiate types of portable devices and sensor fundamentals

CO2: Design and develop a software application for device discovery and communication in portable devices

CO3: Design and develop application using different sensors and services on portable devices

CO4: Design applications in Android wear OS

CO5: Utilize application development GoogleFit platform for portable devices and Database

CO6: Identify the role of portable devices in real world application

Course Contents

Unit I	Introduction	06 Hours

Introduction: Introduction to software development for portable devices, types of Portable Devices, hardware & software for Portable Devices, Applications of Portable Devices, Sensor Fundamentals: Types of sensors (Motion, Position, Environmental), Components of the sensor framework, applications of sensors, Features of Portable Devices, Mobile App development Challenges, Android tooling support

#Exemplar/Case Studies	Study of different sensors with their applications
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Android Device Discovery and communication	06 Hours

Android: An Open Platform for Mobile Development, Android SDK Features, Android Software Stack, Android Application Architecture, Types of Android Applications, Android development tools. **Creating Applications and Activities**: Manifest Editor, Android Application Lifecycle, Android Creating Activities, Activity Lifecycle, Android Activity Classes, Introducing Fragment, Introducing Intents. **Android Interconnectivity**: Advertisement and Discovery, Bluetooth: Remote Device Discovery, Bluetooth Communications, Wi-Fi: Monitoring Wi-Fi Connectivity, Active Wi-Fi Connection, Transferring Data Using Wi-Fi, Transferring Data Between Peers. Near Field Communication: NFC Tags, Android Beam.

#Exemplar/CaseStudies	https://developer.android.com/training/cars , https://developer.android.com/training/tv/start Example: Smartphone Bluetooth App to Control LED Lights
***Mapping of Course Outcomes for Unit II**	CO2

Unit III	**MAPS Location based Services, Audio, Video and**	**06 Hours**

Using Location-Based Services: - Using Location-Based Services, Using the Emulator with Location-Based Services, Selecting a Location Provide,, Using Proximity Alert ,Using the Geocoder , Example: Map-based activity

Hardware Support and Devices (AUDIO, VIDEO, AND USING THE CAMERA): -Using Sensors and the Sensor Manager, Monitoring a Device's Movement and Orientation, Introducing the Environmental Sensors, Playing Audio and Video, Using Audio Effects, Using the Camera, Recording Video

#Exemplar/Case Studies	Example: Map-based activity
***Mapping of Course Outcomes for Unit III**	CO3

Unit IV	**Android Wear OS**	**06 Hours**

Android Wear platform: Android Wear OS, Wear Devices and wear API, Android notifications and android wear, (Android 5.0 Lollipop notification), Google now and Android wear.

Android Wear Devices: Android SDK Wear Platform updates, Procuring an Android Wear device ,Using Android Emulator with Wear AVD, Pairing and Enabling Developer Mode, Unboxing your Wear device, Pairing your Handheld device with your Wear device

Wear Debugging and Android SDK: Wear Debugging and Android SDK via Bluetooth and USB.

Android wear API: Google Services and Google play services, Android Wear Network, Android Wear API (Node Interface, DataEvent, MessagEvent)

#Exemplar/Case Studies	https://wearos.google.com, https://developer.android.com/training/wearables
***Mapping of Course Outcomes for Unit IV**	CO4

Unit V	**Google Fit Platform and API, Databases and Content Providers**	**06 Hours**

Google Fit Platform Overview; Google Fit Core Concepts: Fit Data Types, Fit Data Store (Storage), Sensors; Permissions, User Consent: Permission Groups, Fitness Scopes; Google Fit: Developer Responsibilities: Developer Terms and Conditions, Developer Branding Guidelines; Procuring Sensor Peripherals; Hello Fit: hands- on example

Google Fit API: Google fit main package, Fitness class, Fitness Activities class, Fitness Status Codes class, Ble Api interface, Sensors Api, Recording Api, Sessions Api, History Api, Config Api

Databases and Content Providers: Introducing Android Databases, Introducing SQLite, Content Values and Cursors, Working with SQLite Databases, Creating Content Providers, Using Content Providers

#Exemplar/Case Studies	1. The Fitness Tracker App using Google Fit API. 2. Adding Search to Your Application 3. Native Android Content Providers
***Mapping of Course**	CO5

Unit VI	Real World Application and Future of Portable Devices	06 Hours

Wearable Technology: Wearable Computer, Smartphone and Variety of wearable devices
Real world Application of Portable Devices: Handheld Application, Home Automation, Home Entertainment, Gaming, Wearable at workplace **Fitness, Health and Medical:** Predictive and Proactive Consumer Health, Wearable for Medical Professional, Wearable and remote medical diagnostics Industrial Manufacturing and Safety, Civic, Governance and Democracy

#Exemplar/CaseStu	Portable Devices: Market Estimates and Forecasts, Android Things
***Mapping of Course Outcomes for Unit**	CO6

Learning

Text Books:

1. Varun Nagpal, "Android Sensor Programming By Example", Packt Publishing, 2016, ISBN:978-1-78528-550-9
2. Reto Meier, "Professional Android 4 Application Development", WROX Press, Wiley Publishing, 2012, ISBN: 978-1-118-10227-5
3. Sanjay M. Mishra, "Wearable Android: Android Wear and Google FIT App Development", John Wiley & Sons, 2015, ISBN: 9781119050865

Reference Books:

1. Rick Rogers, John Lombardo, Zigurd Mednieks, Blake Meike, SPD, "Android Application Development, Programming with the Google SDK", Oreilly, ISBN: 13:978-81-8404-733-2
2. Ed Burnette, "Hello Android, Introducing Google's Mobile Development Platform", 3rd edition, Pragmatic Programmers, LLC, ISBN-10: 1-934356-56-5

MOOC Courses:

1. https://www.youtube.com/watch?v=-foyVzTOf8o&list=PLJ5C_6qdAvBEJ6TBzKoa1Ov21lwDzJfM
2. https://archive.nptel.ac.in/courses/106/106/106106156/#

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science & Design (2021Course)
Elective IV (C) 418245: Compiler Design

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

Prerequisite Courses: Theory of Computation (318242), Operating System (218254)

Companion Course : Laboratory Practice IV (418247)

Course Objectives:

- To aware about language translation theories and compiler design stages
- To illustrate the various parser configurations
- To exemplify the use of syntax directed translation in intermediate code
- To Understand Storage Management and Control Structure Environment .
- Learn to develop a Code generator
- To demonstrate the numerous optimization methods used in the creation of different optimizing compilers

Course Outcomes:

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

CO1: Design and implement a lexical analyzer using LEX tools
CO2: Design and implement a syntax analyzer using YACC tools
CO3: Understand syntax-directed translation and run-time environment
CO4: Generate intermediate codes for high-level statements.
CO5: Construct algorithms to produce computer code.
CO6: Analyze and transform programs to improve their time and memory efficiency

Course Contents

Unit I	Notion and Concepts	08 Hours

Introduction to compilers Design issues, passes, phases, symbol table Preliminaries Memory management, Operating system support for compiler, Lexical Analysis Tokens, Regular Expressions, Process of Lexical analysis, Block Schematic, Automatic construction of lexical analyzer using LEX, LEX features and specification.

#Exemplar/Case Studies	Study of LEX Compiler
*Mapping of Course Outcomes for Unit-I	CO1

Unit II	Parsing	08 Hours

Syntax Analysis CFG, top-down and bottom-up parsers, RDP, Predictive parser, SLR, LR(1), LALR parsers, using ambiguous grammar, Error detection and recovery, automatic construction of parsers using YACC, Introduction to Semantic analysis, Need of semantic analysis, type checking and type conversion.

#Exemplar/Case Studies	Study of YAAC
*Mapping of Course Outcomes for Unit II	CO2

Unit III	Syntax Translation Schemes	08 Hours
Syntax Directed Translation - Attribute grammar, S and L attributed grammar, bottom up and top down evaluations of S and L attributed grammar, Syntax directed translation scheme, Intermediate code - need, types: Syntax Trees, DAG, Three-Address codes: Quadruples, Triples and Indirect Triples, Intermediate code generation of declaration statement and assignment statement.		
#Exemplar/Case Studies	Applications of Syntax Directed Translation	
*Mapping of Course Outcomes for Unit III	CO3	
Unit IV	**Run-time Storage Management**	**08 Hours**
Storage Management – Static, Stack and Heap, Activation Record, static and control links, parameter passing, return value, passing array and variable number of arguments, Static and Dynamic scope, Dangling Pointers, translation of control structures – if, if-else statement, Switch-case, while, do -while statements, for, nested blocks, display mechanism, array assignment, pointers, function call and return. Translation of OO constructs: Class, members and Methods.		
#Exemplar/Case Studies	CARAT - Compiler and runtime based address translation model	
*Mapping of Course Outcomes for Unit IV	CO4	
Unit V	**Code**	**07 Hours**
Code Generation - Issues in code generation, basic blocks, flow graphs, DAG representation of basic blocks, Target machine description, peephole optimization, Register allocation and Assignment, Simple code generator, Code generation from labeled tree, Concept of code generator.		
#Exemplar/Case Studies	Code Generator for a Virtual Machine Code based JavaScript Compiler	
*Mapping of Course Outcomes for Unit V	CO5	
Unit VI	**Code**	**07 Hours**
Need for Optimization, local, global and loop optimization, Optimizing transformations, compile time evaluation, common sub-expression elimination, variable propagation, code movement, strength reduction, dead code elimination, DAG based local optimization, Introduction to global data flow analysis, Data flow equations and iterative data flow analysis.		
#Exemplar/Case Studies	Execution of super-scalar processors	
*Mapping of Course Outcomes for Unit VI	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 81-265-0418-8

Reference Books:

1. Anthony J. Dos Reis, –Compiler Construction Using Java‖, JavaCC and Yacc Wiley, ISBN 978-0-470-94959-7
2. K Muneeswaran, –Compiler Design", Oxford University press, ISBN 0-19-806664-3
3. J R Levin, T Mason, D Brown, –Lex and Yacc", O'Reilly, 2000 ISBN 81-7366-061-X

eBooks:

1. **Basics of Compiler Design**
   http://hjemmesider.diku.dk/~torbenm/Basics/basics_lulu2.pdf
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	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
Final Year of Computer Science and Design (2021 Course)
Elective IV (D) 418245: Advanced UI/UX Design

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

Prerequisites Courses: UI/UX Design (318253)
Proficiency in design tools such as Adobe XD, Sketch, or Figma
Familiarity with HTML/CSS and prototyping tools is recommended

Companion Course: Laboratory Practice IV (418247)

Course Objectives:

- Explore advanced UI/UX design principles and theories
- Develop proficiency in advanced design tools and techniques
- Apply design thinking methodologies to solve complex design problems
- Create high-fidelity prototypes for web and mobile applications
- Understand user research methods and usability testing techniques
- Collaborate effectively with multidisciplinary teams

Course Outcomes:

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

CO1: Develop a comprehensive understanding of advanced user psychology principles
CO2: Master a wide range of interactive design patterns
CO3: Gain proficiency in advanced usability testing methods
CO4: Learn to develop taxonomies and ontologies
CO5: Develop advanced skills in crafting strategic brand identities
CO6: Develop advanced skills in designing immersive and interactive user experiences

Course Contents

Unit I	Advanced User Psychology and Design Principles	08 Hours

- Advanced Human Centered Design: Deep dive into cognitive psychology, emotional design, and user behavior analysis.
- Advanced User Research Methods: Ethnographic studies, longitudinal studies, and biometric analysis for understanding user needs and behaviors.
- Design for Diversity and Accessibility: Advanced techniques for designing inclusive interfaces for diverse user groups.

#Exemplar/Case Studies	Redesigning a Social Networking Platform for Diverse User Groups.
***Mapping of Course Outcomes for Unit I**	CO1

Unit II	Advanced Interaction Design	08 Hours

- Advanced Prototyping Techniques: High-fidelity prototyping, motion design, and micro-interactions.
- Advanced Animation and Transition Design: Principles of animation applied to UI design, creating seamless transitions for enhanced user experience.
- Advanced Gesture and Voice Interfaces: Designing intuitive gesture-based and voice-controlled interfaces for various platforms.

#Exemplar/Case Studies	Redesigning a Virtual Reality (VR) Application for Enhanced Immersive Interaction

***Mapping of Course Outcomes for Unit II**	CO1,CO2	
Unit III	**Advanced Usability Testing and Evaluation**	**08 Hours**
• Advanced Usability Metrics: Beyond basic usability metrics, advanced metrics like task efficiency, error recovery, and emotional engagement. • Advanced Usability Testing Methods: Remote usability testing, multi-device testing, and eye-tracking studies. • Advanced Analytics and Interpretation: Utilizing advanced analytics tools to extract actionable insights from usability data.		
#Exemplar/Case Studies	Conducting a Multinational Usability Study for a Global E-Commerce Platform.	
***Mapping of Course OutcomesforUnitIII**	CO3	
Unit IV	**Advanced Information Architecture and Navigation**	**08 Hours**
• Advanced Information Design: Hierarchical and non-hierarchical information structures, semantic web principles, and ontology design. • Advanced Navigation Patterns: Mega menus, faceted navigation, and predictive navigation for complex information systems. • Advanced Search Interface Design: Implementing advanced search algorithms, natural language processing, and voice search.		
#Exemplar/Case Studies	Redesigning a Knowledge Management System for Enterprise Use.	
***Mapping of Course Outcomes for Unit IV**	CO4	
Unit V	**Advanced Visual Design and Branding**	**08 Hours**
Advanced Visual Hierarchy and Composition: Gestalt principles applied to visual design, advanced grid systems, and typography. Advanced Branding in UI/UX: Brand personality integration, emotional branding, and consistency across touchpoints. Advanced Color Theory and Psychology: Color psychology, cultural considerations, and advanced color schemes for different contexts.		
#Exemplar/Case Studies	Redesigning a Fashion E-Commerce Platform with a Strong Brand Identity.	
***Mapping of Course Outcomes for Unit V**	CO5	
Unit VI	**Advanced Emerging Technologies in UI/UX**	**07 Hours**
#Exemplar/Case Studies	Designing an AI-Powered Personal Assistant App for Enhanced User Productivity.	
***Mapping of Course Outcomes for Unit VI**	CO6	

Learning Resources

Text Books:

1. Creative Tim ,"Fundamentals of Creating a Great UI/UX", 1st Edition
2. Don Norman ,"The Design of Everyday Things"
3. Jeff Gothelf and Josh Seiden ,"Lean UX: Designing Great Products with Agile Teams"

Reference Books :

1. Susan Weinschenk , "Things Every Designer Needs to Know About People" ,2011 by New Riders, an imprint of Pearson Education, ISBN: 978-0321767530
2. Jenifer Tidwell,"Designing Interfaces: Patterns for Effective Interaction Design" ,O'Reilly Media, ISBN: 978-0596008031
3. Louis Rosenfeld, Peter Morville, and Jorge Arango,"Information Architecture: For the Web and Beyond",O'Reilly Media, ISBN:978-1491911686
4. Jesse James Garrett,"The Elements of User Experience: User Centered Design for the Web and Beyond", New Riders, ISBN:978-0735712027
5. Don Norman ,"Emotional Design: Why We Love (or Hate) Everyday Things", Basic Books,ISBN:978-0465051366

e-Books :

1) https://www.uxpin.com/studio/ebooks/prototyping-product-managers-requirements-analysis/
2)http://secure.fabriceleven.com/1fEdx+

MOOC Courses links :

1) https://coursera.org/professional-certificates/google-ux-design
2) https://www.coursera.org/learn/web-design-strategy?specialization=ui-ux-design
3) https://www.henryharvin.com/advanced-certification-uiux-design-strategy

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science & Design (2021Course)
418246: Laboratory Practice III

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

Companion Course: Computer Vision (418241), Deep Learning (418242), Game Design & Development (418243)

Course Objectives:

- To implement different deep learning models
- To review image processing techniques for computer vision.
- Implement and evaluate supervised and unsupervised machine learning algorithms.
- To understand Feature extraction techniques.
- To demonstrate core game design principles through paper prototyping.
- To apply player controls, such as movement, in game development tasks

Course Outcomes:

After completion of the course, students will be able to:
CO1: Apply the technique of Convolution (CNN) for implementing Deep Learning models
CO2: Design and develop Recurrent Neural Network (RNN) for prediction
CO3: Develop skills to develop applications using computer vision techniques
CO4: Apply feature extraction techniques
CO5: Make use of game development mechanics
CO6: Build a game for a given task

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 Conduction

Use of open source software is to be encouraged. Operating System recommended: - Linux or its derivative.
Programming tools recommended: - Open Source line gcc /g++/python ,C# /Unity
OpenCV computer vision Library for OpenCV in Python /PyCharm or C++/Visual Studio or equivalent

Suggested List of Laboratory Experiments/Assignments **Assignments from all the Groups (A, B, C) are compulsory**	
Group A: Computer Vision	
Any 3 Assignments and 1 Mini Project are Mandatory	
Group 1	
1.	OpenCV Installation and working with Python
2.	Basic Image Processing - loading images, Cropping, Resizing, Thresholding, Contour analysis, Bolb detection
3.	Image Annotation – Drawing lines, text circle, rectangle, ellipse on images
4.	Image Enhancement - Understanding Color spaces, color space conversion, Histogram equialization, Convolution, Image smoothing, Gradients, Edge Detection
5.	Image Features and Image Alignment – Image transforms – Fourier, Hough, Extract ORB Image features, Feature matching, cloning, Feature matching based image alignment
6.	Image segmentation using Graphcut / Grabcut
Group 2: Mini Project	
Group B: Deep Learning	
Any 3 Assignments and 1 Mini Project are Mandatory	
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 dataset https:// 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
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
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

7.	**Mini Project:** Colorizing Old B&W Images: color old black and white images to colorful images

Group C: Game Design and Development

Any 3 Assignments and 1 Mini Project are Mandatory

Group 1	
1	Create a paper prototype of a game idea, focusing on core gameplay mechanics and level layout. This involves drawing out the game's interface, levels, and key interactions on paper, allowing for quick iteration and testing
2	Create a basic game where the player can move a character using arrow keys or WASD. (Use Unity)
3	Build a game where the player needs to avoid obstacles by jumping or moving left/right using simple controls in Unity. Add a scoring system to the game that increases whenever the player collects items or achieves goals
4	Implement simple enemies that chase the player or move around the game environment. Build levels for the game and allow the player to move between them once they complete the objectives of current levels.
Group 2	**Mini Project**

@The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science & Design (2021Course)
418247: Laboratory Practice IV

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

Companion Course: Elective III (418244), Elective IV (418245)

Course Objectives:

- Understand and explore the working of Blockchain technology and its applications.
- To understand the fundamental concepts and techniques of natural language processing (NLP)
- To learn the fundamentals of software development for portable devices
- Understand information retrieval process using standard tools available
- Learn installation and use of open source software testing tools
- Understand various vulnerabilities and use of various tools for assessment of vulnerabilities

Course Outcomes:

After completion of the course, students will be able to:

CO1: Interpret the basic concepts in Blockchain technology and its applications
CO2: Identify various vulnerabilities and demonstrate using various tools.
CO3: Apply information retrieval tools for natural language processing
CO4: Apply software testing tools to perform automated testing

Guidelines for Instructor's Manual

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

Guidelines for Student's Laboratory Journal

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

Guidelines for Laboratory/Term Work Assessment

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

Guidelines for Practical Examination

Problem statements must be decided jointly by the internal examiner and external examiner. During practical assessment, maximum weightage should be given to satisfactory implementation of the

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

Guidelines for Laboratory Conduction

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

Virtual Laboratory:

- htt ps :// hci -ii tg .v l abs . ac . i n/
- **http://vlabs.iitkgp.ernet.in/se/**
- **https://vlab.amrita.edu/?sub=3&brch=179&sim=1293&cnt=2**

Elective III (A): Object Oriented Modelling and Design

Any 4 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 2
8.	**Mini Project:** Draw all UML diagrams for your project work.
9.	**Mini Project -** Develop a Blockchain based application for health related medical records Draw following UML Diagrams for Bank Management application: a. Class Diagram b. Object Diagram c. ER Diagram d. Component Diagram

Elective III (B): Software Testing and Quality Assurance	
Any 4 assignments from group 1 and 1 Mini project from group 2 is mandatory	
Group 1:	
1.	Write TEST Scenario for Gmail Login Page
2.	Test Scenario for Gmail Login Page
3.	Write Test cases in excel sheet for Social Media application or website
4.	Create Defect Report for Any application or web application
5.	Installation of Selenium grid and selenium Web driver java eclipse (automation tools).
6.	Prepare Software requirement specification for any project or problem statement
Group 2:	
7.	**Mini Project: Software** Testing and Quality Assurance Mini Project Dynamic website of covid-19 information using HTML, CSS, JAVASCRIPT And PHP, MySQL database used to store user account, comment, and registration form details. Regular Expression testcases for testing purpose
8.	**Mini Project: Create** a small application by selecting relevant system environment / platform and programming languages. Narrate concise Test Plan consisting features to be tested and bug taxonomy. Prepare Test Cases inclusive of Test Procedures for identified Test Scenarios.

Elective III (C): Blockchain Technology	
Any 4 assignments and 1 Mini project from group 2 is 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.	Write a program to create a Business Network using Hyperledger

Group 2	
7	**Mini Project -** Develop a Blockchain based application dApp (de-centralized app) for e-voting system.
8	**Mini Project -** Develop a Blockchain based application for transparent and genuine charity
9	**Mini Project -** Develop a Blockchain based application for health related medical records
10	**Mini Project -** Develop a Blockchain based application for mental health

Elective III (D): Information Retrieval

Any 4 assignments from group 1 and 1 Mini project from group 2 is mandatory

Group 1	
1.	Write a program to Compute Similarity between two text documents.
2.	Implement Page Rank Algorithm.
3.	Write a program for Pre-processing of a Text Document: stop word removal.
4.	Write a map-reduce program to count the number of occurrences of each alphabetic character in the given dataset. The count for each letter should be case-insensitive (i.e., include both upper- case and lower-case versions of the letter; Ignore non-alphabetic characters).
5.	Write a program to implement simple web crawler.
6.	Write a program to parse XML text, generate Web graph and compute topic specific page
Group 2	
7.	Mini project: Develop Document summarization system
8.	Mini Project: Develop Tweet sentiment analysis system
9.	Mini Project: Develop Fake news detection system
10	Mini Project: Develop a Abstractive summarization system

Elective IV (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 nltklibrary. 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 ondata. 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 (anymethod), 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 ofyour choice: • Neural Machine Translation • Classification • Summarization
Virual Lab:https://nlp-iiith.vlabs.ac.in/	
Elective IV (B) Software Development for Portable Devices	
Group 1	
Any 4 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 at least 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.
Elective IV (C) Compiler Design	
Any 4 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

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 At least 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.

Elective IV (D): Advanced UI/UX Design

Any 4 assignments from group 1 and 1 Mini project from group 2 is mandatory.

Group 1

1	Redesign a Complex Interface: Choose a complex application or website interface (e.g., a banking app, project management tool, or e-commerce platform) and redesign it with a focus on improving user experience. Consider factors like information architecture, visual hierarchy, usability, and accessibility.
2	Create a Responsive Design: Design a website or application that adapts seamlessly to various screen sizes and devices. This assignment will involve creating wireframes and prototypes for desktop, tablet, and mobile views, ensuring consistency and usability across different platforms.
3	Design a Dashboard: Develop a dashboard interface for a specific user persona or industry (e.g., data analytics, social media management, or healthcare). Focus on presenting complex data in a visually appealing and easy-to-understand format, incorporating interactive elements and customizable features.
4	Accessibility Audit and Redesign: Choose an existing website or application and conduct an accessibility audit using tools like WAVE or Axe. Identify accessibility issues and redesign the interface to meet WCAG (Web Content Accessibility Guidelines) standards, ensuring inclusivity for users with disabilities.
5	User Testing and Iteration: Create a prototype of a new feature or product concept and conduct user testing sessions with target users. Gather feedback on usability, navigation, and overall experience, and iterate on the design based on user insights to improve usability and satisfaction.
6	Design System Development: Develop a design system for a company or product, including components such as typography, color palette, iconography, and UI patterns. Create comprehensive documentation and design assets to ensure consistency and scalability across different projects and teams.
7	Motion Design and Microinteractions: Design microinteractions and animations to enhance user engagement and delight. Create prototypes demonstrating how subtle animations can improve feedback, transitions, and visual cues within the interface, enhancing the overall user experience.
8	Augmented Reality (AR) Interface: Explore the design principles and challenges of designing interfaces for augmented reality experiences. Create wireframes and prototypes for an AR application, considering factors like spatial awareness, interaction paradigms, and immersive user interfaces.

9	Gamification in UI/UX: Incorporate gamification elements into a non-gaming application or website to drive user engagement and behavior change. Design interactive elements such as progress bars, achievements, badges, and rewards systems to motivate users and enhance the overall user experience.
Group2	
10	**Mini Project**

@The CO-PO Mapping Matrix

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 & Design (2021Course)
418248: Project Work Stage I

Teaching Scheme: Practical:02Hours/Week	Credit02	Examination Scheme: Presentation:50Marks

Course Objectives:

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

Course Outcomes:

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

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

Guidelines

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

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

Savitribai Phule Pune University
Fourth Year of Computer Science & Design (2021Course)
418249: 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 Computer Science & Design (2021Course)
418249: Audit Course 7
AC7– I: MOOC-learn New Skill

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

Course Objectives:

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

Course Outcomes:

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

CO1: To acquire additional knowledge and skill.

About Course

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

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

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

Guidelines:

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

References:

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 Science & Design (2021Course)
418249: 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 Science & Design (2021Course)
418249: Audit Course 7
AC7 – III: Botnet of Things

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

Course Objectives:

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

Course Outcomes:

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

CO1: Implement security as a culture and show mistakes that make applications vulnerable to attacks.CO2: Understand various attacks like DoS, buffer overflow, web specific, database specific, web
-spoofing attacks.
CO3: Demonstrate skills needed to deal with common programming errors that lead to most security problems and to learn how to develop secure applications

Course Contents

1. **Introduction**
2. **IRC-Based Bot Networks**
3. **Anatomy of a Botnet: The Gaobot Worm**
4. **IoT Sensors and Security :** Sensors and actuators in IoT, Communication and networking in IoT, Real-time data collection in IoT, Data analytics in IoT , IoT applications and requirements, Security threats and techniques in IoT, Data trustworthiness and privacy in IoT, Balancing utility and other design goals in IoT , Future of Botnets in the Internet of Things, Thing bots, 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. IBMInternet Security Systems.
4. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2MCommunications", 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/dreMike Kuniavsky, "Smart Things: Ubiquitous Computing User Experience Design," Morgan KaufmannPublishers.

Savitribai Phule Pune University
Fourth Year of Computer Science & Design (2021Course)
418249: Audit Course 7
AC7 – IV: 3D Printing

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

Course Objectives:

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

Course Outcomes:

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

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

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

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

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

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

Course Contents

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

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

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

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

Books:

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

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

3. 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 & Design (2021Course)
418249: Audit Course 7
AC7 – V: Industrial Safety and Environment Consciousness

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

Course Objectives:

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

Course Outcomes:

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

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

Course Contents

1. **Introduction:** Elements of safety programming, safety management, upgrading developmental programmers: safety procedures and performance measures, education, training and development in safety.
2. **Safety Performance Planning:** Safety Performance: An overview of an accident, It is an accident, injury or incident, The safety professional, Occupational health and industrial hygiene. Understanding the risk: Emergency preparedness and response, prevention of accidents involving hazardous substances.
3. **Accident Prevention:** What is accident prevention?, Maintenance and Inspection, Monitoring Techniques, General Accident Prevention, Safety Education and Training.
4. **Organization Safety:** Basic Elements of Organized Safety, Duties of Safety Officer, Safe work Practices, Safety Sampling and Inspection, Job Safety Analysis (JSA), Safety Survey, On- site and Off-site Emergency Plan, Reporting of Accidents and Dangerous Occurrences.
5. **Industrial Pollution:** Introduction, Work Environment, Remedy, pollution of Marine Environment and Prevention, Basic Environmental Protection Procedures, Protection of Environment in Global Scenario, Greenhouse Gases, Climate Change Impacts, GHG Mitigation Options, Sinks and Barriers,
6. **Industrial Security(Industry wise):**General security Systems in Factories, Activation Security, Computer Security, Banking Security,V.I.P. Security, Women Security, Event Security, Security in Open Environments.

Books :

1. Basudev Panda ,“Industrial Safety, Health Environment and Security”,Laxmi Publications, ISBN-10: 9381159432, 13: 978-9381159439
2. L.M. Deshmukh, “Industrial Safety Management”, TMH , ISBN: 9780070617681

SEMESTER VIII

Savitribai Phule Pune University
Fourth Year of Computer Science & Design (2021Course)
418250: Information and Cyber Security

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	Mid_ Semester (TH): 30 Marks End_ Semester (TH): 70 Marks

Prerequisite Courses, if any: Computer Networks (218255)

Companion Course, if any: Laboratory Practice V (418254)

Course Objectives:

- To offer an understanding of principle concepts, central topics and basic approaches in information and cyber security.
- To know the basics of cryptography.
- To acquire knowledge of standard algorithms and protocols employed to provide confidentiality, integrity and authenticity.
- To enhance awareness about Personally Identifiable Information (PII), Information management, cyber forensics.

Course Outcomes:

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

CO1: Gauge the security protections and limitations provided by today's technology.
CO2: Identify cyber security threats.
CO3: Analyze and evaluate the cyber security needs of an organization.
CO4: Analyze threats in order to protect or defend it in cyberspace from cyber-attacks.
CO5: Build appropriate security solutions against cyber-attacks
CO6: Design operational and strategic cyber security strategies and policies.

Course Contents

Unit I	Introduction	(06 Hours)

Introduction, Elements of Information Security, Security Policy, Techniques, Steps, Categories, Operational Model of Network Security, Basic Terminologies in Network Security. Threats and Vulnerability, Difference between Security and Privacy.

#Exemplar/Case Studies	Case study on cyber attacks
Mapping of Course Outcomes for Unit I	C01, C02

Unit II	Data Encryption Techniques And Standards	(08Hours)

Introduction, Encryption Methods: Symmetric, Asymmetric, Cryptography, Substitution Ciphers. Transposition Ciphers, Stenography applications and limitations, Block Ciphers and methods of operations, Feistal Cipher, Data Encryption Standard (DES), Triple DES, Weak Keys in DES Algorithms, Advance Encryption Standard (AES).

#Exemplar/Case Studies	Symmetric encryption algorithm case study

Mapping of Course Outcomes for Unit II	C03, C04	
Unit III	**Public Key And Management**	**(08 Hours)**
Public Key Cryptography, RSA Algorithm: Working, Key length, Security, Key Distribution, Deffie-Hellman Key Exchange, Elliptic Curve: Arithmetic, Cryptography, Security, Authentication methods, Message Digest, Kerberos, X.509 Authentication service. Digital Signatures: Implementation, Algorithms, Standards (DSS), Authentication Protocol.		
#Exemplar/Case study	Public encryption algorithm case study	
Mapping of Course Outcomes for Unit III	C03, C04	
Unit IV	**Security Requirements**	**(06Hours)**
IP Security: Introduction, Architecture, IPV6, IPv4, IPSec protocols, and Operations, AH Protocol, ESP Protocol, ISAKMP Protocol, VPN. WEB Security: Introduction, Secure Socket Layer (SSL), SSL Session and Connection, SSL Record Protocol, Change Cipher Spec Protocol, Alert Protocol, Handshake Protocol. Electronic Mail Security: Introduction, Pretty Good Privacy, MIME, S/MIME, Comparison. Secure Electronic Transaction (SET).		
#Exemplar/Case Studies	Cisco Security case study	
Mapping of Course Outcomes for Unit IV	C04, C05	
Unit V	**Firewall And Intrusion**	**(08Hours)**
Introduction, Computer Intrusions. Firewall Introduction, Characteristics and types, Benefits and limitations. Firewall architecture, Trusted Systems, Access Control. Intrusion detection, IDS:Need, Methods, Types of IDS, Password Management, Limitations and Challenges.		
#Exemplar/Case Studies	Firewall And Intrusion case study	
Mapping of Course Outcomes for Unit V	C05	
Unit VI	**Cyber Forensic, Hacking& its countermeasures**	**(06 Hours)**
Personally Identifiable Information (PII), Cyber Stalking, Cybercrime, PII Confidentiality Safeguards, Information Protection Law: Indian Perspective. Hacking: Remote connectivity and VoIP hacking, Wireless Hacking, Mobile Hacking, countermeasures		
#Exemplar/Case Studies	Cyber Forensics, ethical hacking case study	

Mapping of Course Outcomes for Unit VI	C06

Learning Resources

Text Books:

1. Dr. V.K. Pachghare, Cryptography and Information Security, PHI, ISBN 978-81-303-5082-3
2. Nina Godbole,SunitBelapure, Cyber Security,Wiley India, ISBN:978-81-345-2179-1
   PDF Digital Content : Stuart McCLURE, Joel Scambray, George Kurtz, Hacking Exposed
3. Network Security Secrets and Solutions, McGrowHill, 2012 ISBN: 978-0-07-178028-5 Digital Ref: http://84.209.254.175/linux-pdf/Hacking-Exposed-7-Network-Security-Secrets.pdfCollege libraries are requested to purchase the copy

Reference Books:

1. William Stallings, "Cryptography and Network Security: Principles and Practice", 7/e, Pearson,ISBN:9789332585225. https://pearsoned.co.in/web/books/9789332585225_Cryptography-and-Network- Security_William-Stallings.aspx
2. Atul Kahate, "Cryptography and Network Security", Mc Graw Hill Publication, 2nd Edition, 2008, ISBN : 978-0-07-064823-4

e-Books: https://www.simplilearn.com/introduction-to-cyber-security-beginners-guide-pdf

MOOC Courses: https://onlinecourses.swayam2.ac.in/cec20_cs15/preview

@The CO-PO mapping table

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

Savitribai Phule Pune University, Pune
Fourth Year of Computer Science & Design (2021Course)
418251: Generative AI

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

Prerequisites Courses: - Artificial Intelligence (318251)

Companion Course: Laboratory Practice V (418254)

Course Objectives:

- To understand the fundamentals of Generative Adversarial Networks (GANs)
- To acquire knowledge on how to use Generative AI techniques in software development.
- To understand language model architectures, training methods.
- To study the role of prompt engineering in NLP model development.

Course Outcomes:

1. Understand generative AI, including its underlying principles, techniques, and applications.
2. Understand language model their architecture and applications
3. Explain the fundamentals of deep generative models
4. Identify role of Large Language Model for text generation
5. Identify the role of NLP within AI contexts
6. Illustrate the techniques and Application for Prompt Engineering

Course Contents

Unit I	Introduction to Generative AI	07 Hours

Introduction to generative AI , Some fascinating metrics ,How generative AI works
ML model vs. gen AI model, Journey from traditional programming to neural networks to generative AI, Definition and scope of Generative AI Overview of generative models and their applications Importance of Generative AI in various domains .Brief discussion on ethical considerations and challenges Applications of Generative AI in Different Industries

#Exemplar/Case Studies	Image Synthesis in Fashion Design
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Language Models	07 Hours

Small and Large Language Models (LLM): Powering generative AI , How do LLMs work? Different Large Language Models, LLM Architectures: Components of an LLM, How do LLMs learn? their role in AI Building an LLM application , LLMs use cases, Content creation Education Customer service and support, Research and development, Entertainment and media, Limitations of LLMs, Traditional approaches to language modeling, Deep learning-based language models and their Advantages, Overview of popular LLM architectures: RNNs, LSTMs, and Transformers

***Mapping of Course Outcomes for Unit II**	CO2	
Unit III	**Deep Generative Models**	**07 Hours**
Deep Generative Models: Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), Autoregressive Models (e.g., PixelCNN, WaveNet)		
#Exemplar/Case Studies	Art Creation and Appreciation	
***Mapping of Course Outcomes for Unit III**	CO3	
Unit IV	**Large Language Models for Text Generation**	**07 Hours**
Vector Representations, Transformer Architecture, Probabilistic Text Generation, The Rise o Transformer Architectures, OpenAI's Generative Pre-Trained Transformers GPT-3.5-turbo and ChatGPT GPT-4 Google's Gemini Meta's LLaMA		
#Exemplar/Case Studies	Text Generation and Creative Writing	
***Mapping of Course Outcomes for Unit IV**	CO4	
Unit V	**Large Language Models for NLP**	**07 Hours**
Introduction to NLP, Language Models, Statistical Model (n-Grams), Knowledge based Models, Contextual language Models, Neural Network Based Models, Transformer Models.		
#Exemplar/CaseStudies	Medical Imaging and Diagnosis:	
***Mapping of Course Outcomes for Unit V**	CO5	
Unit VI	**Prompt Engineering for Generative AI**	**07 Hours**
Introduction to prompt engineering, Principles of Effective Prompts, Crafting Compelling Prompts, Generative Pre-trained Transformers (GPT) models, API usage vs. web interface, Tokens, Costs, tokens and initial prompts: how to calculate the cost of using a model, Understanding the API parameters, Vector Databases, Retrieval Augmented Generation (RAG) Prompt Engineering Techniques- Zero shot & Few shot prompting, Chain of Thought (COT), Automatic Chain of Thought (Auto- COT), Chain- of- Symbol (CoS), Tree- of- Thoughts (ToT), Graph of Thoughts (GoT), Chain- of- Verification (CoVe), Chain- of- Code (CoC), Application: Question-Answering Systems, Conversational AI, Sentiment Analysis, Template-Based Prompt Generation, Text Augmentation		
#Exemplar/CaseStudies	Creative Writing Assistant	

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

Learning Resources

Text Books:

1. Ethan James Whitfield , “Generative AI for Beginners”, Independently published, ISBN-13: 979-8869928337
2. Tom Taulli, ”Generative AI”, Springer ,Apress, 2023,ISBN : 978-1-4842-9369-0
3. David Foster , "Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play" O'Reilly Media, ISBN-13: 978-1492041948
4. James Phoenix, Mike Taylor, “Prompt Engineering for Generative AI”, O'Reilly Media, Inc., ISBN: 9781098153434
5. Aymen El Amri, Leanpub, “LLM Prompt Engineering for Developers”, Independently published, ISBN-13: 979-8859940714

Reference Books :

1. Josh Kalin,”Generative Adversarial Networks Cookbook: Over 100 recipes to build generative models using Python, TensorFlow, and Keras" Packt Publishing ISBN-13: 978-1789139907
2. Robert E. Miller, “Prompt Engineering Bible: Join and Master the AI Revolution”, Independently Published, ISBN-13: 979-8861782944
3. Hobson Lane, Hannes Hapke, and Cole Howard, “Natural Language Processing in Action: Understanding, analyzing, and generating text with Python”, Manning Publications,1st Edition, ISBN-13: 978-1617294631
4. Scikit-Learn, Keras, and Tensor Flow, “Hands-On Machine Learning”, O'Reilly Media, 2nd Edition. ISBN-13: 978-9352139057
5. François Chollet, “Deep Learning with Python”, Manning Publications, 2nd Edition, ISBN 9781617296864

e Books : Mastering Prompt Engineering: A Free eBook | by Natasha | Medium

CO/PO Mapping

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

Savitribai Phule Pune University
Fourth Year of Computer Science and Design (2021Course)
Elective V 418252(A): Computational Intelligence

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

Prerequisites Courses: Artificial Intelligence (318251)

Companion Course: Laboratory Practice VI (418255)

Course Objectives:

- To provide students with a comprehensive understanding of the fundamental concepts, theories, and techniques in the field of computational intelligence
- To understand, explain, and apply the fuzzy set and fuzzy logic in real life applications
- To familiarize with various evolutionary algorithms and optimization techniques inspired by natural evolution processes
- To understand the principles, techniques, and applications of genetic algorithms
- To apply computational intelligence techniques to solve complex NLP problems
- To introduce the concepts inspired by the human immune system and their application in problem-solving and optimization

Course Outcomes:

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

CO1: Understand Computational Intelligence techniques to solve real-life problems
CO2: Apply fuzzy logic techniques to solve real life problems
CO3: Design and implement evolutionary algorithms to solve optimization problem
CO4: Analyze and evaluate the performance of genetic algorithms in terms of convergence and computational efficiency
CO5: Interpret and analyze the results obtained from computational intelligence models in NLP, providing meaningful insights and recommendations
CO6: Design and Develop Artificial Immune System to solve complex problems

Course Contents

Unit I	Introduction To Computational Intelligence	07 Hours

Introduction to Computational Intelligence, Paradigms of Computational Intelligence, Difference between Artificial Intelligence and Computational Intelligence, Approaches to Computational Intelligence, Synergies of Computational Intelligence Techniques, Applications of Computational Intelligence, Grand Challenges of Computational Intelligence

#Exemplar/Case Studies	Study of Intelligent Waste Classification System using Computational Intelligence
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Fuzzy Logic	07Hours
Introduction to Fuzzy Set- Introduction, definition, membership Function, Fuzzy operator, Fuzzy Set Characteristics, Fuzziness and Probability. **Fuzzy Logic and Reasoning**–Fuzzy Logic: Linguistics Variables and Hedges, Fuzzy Rules. Fuzzy Inferencing: neuro inferencing Fuzzification, Defuzzification **Fuzzy logic Controllers**: Fuzzy logic Controllers, Fuzzy logic Controller Types		
#Exemplar/Case Studies	Study of Object Detection Robot Using Fuzzy Logic Controller	
***Mapping of Course Outcomes for Unit II**	CO2	
Unit III	**Evolutionary Computing**	**07 Hours**
Introduction, Evolutionary Computing, Terminologies of Evolutionary Computing, Genetic Operators, Evolutionary Algorithms: - Genetic Algorithm, Evolution Strategies, Evolutionary Programming, Genetic Programming, Performance Measures of EA, Evolutionary Computation versus Classical Optimization. **Advanced Topics**: Constraint Handling, Multi-objective Optimization, Dynamic Environments **Swarm Intelligence:** Ant Colony Optimization		
#Exemplar/Case Studies	Study of Engineering application of Artificial humming bird algorithm	
***Mapping of Course Outcomes for Unit III**	CO3	
Unit IV	**Genetic Algorithm**	**07 Hours**
Introduction to Basic Terminologies in Genetic Algorithm: Individuals, Population, Search space, Genes, Fitness function, Chromosome, Trait, Allele, Genotype and Phenotype. **GA Requirements and representation**- Binary Representations, Floating-Point Representations **Operators in Genetic Algorithm**: Initialization, Selection, Crossover (Recombination), Mutation; fitness score, Stopping Condition, reproduction for GA Flow, Constraints in Genetic Algorithms. **Genetic Algorithm Variants:** Canonical Genetic Algorithm (Holland Classifier System), Messy Genetic Algorithms, Applications, and benefits 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. Repeat Until stopping criteria is met. 7.Stop	
***Mapping of Course Outcomes for Unit IV**	CO4	
Unit V	**Computational Intelligence and NLP**	**07 Hours**
Introduction, Word embedding Techniques-Bag of Words, TF-IDF,Word2Vec, Glove, Neural word embedding, Neural Machine Translation, Seq2Seq and Neural Machine Translation, translation Metrics (BLEU Score & BERT Score) , Traditional Versus Neural Metrics for Machine Translation Evaluation, Neural Style Transfer, Pertained NLP BERT Model and its application		

#Exemplar/Case Studies	1) Study of Patient Triage using ChatGPT which can be utilized by physicians for expedited diagnoses. 2) Study of Question Answering System with BERT
***Mapping of Course Outcomes for Unit V**	CO5

Unit VI	**Artificial Immune Systems**	**07 Hours**

Natural Immune System, Artificial Immune Models, Artificial Immune System Algorithm, Classical View Models, Clonal Selection Theory Model, Network Theory Model, Danger Theory Model, Dendritic cell Model, Applications of AIS models

#Exemplar/Case Studies	Study of an artificial immune system with bootstrap sampling for the diagnosis of recurrent endometrial cancers
***Mapping of Course Outcomes for Unit VI**	CO6

Learning Resources

Text Books:

1. Andreis P. Engelbrecht, "Computational Intelligence an introduction", 2nd edition, Wiley publication
2. Nazmul Siddique, Hojjat Adeli, "Computational Intelligence, Synergies of Fuzzy logic, Neural Networks and Evolutionary computing", Wiley publication
3. S. Rajasekaran, G. A. Vijayalakshami, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications", PHI, 2007

Reference Books:

1. Seyedali Mirjalili, "Evolutionary Algorithms and Neural Networks Theory and Applications, Studies in Computational Intelligence", Vol 780, Springer, 2019,
2. Sitendra Tamrakar, Shruti Bhargava Choubey, Abhishek Choubey, "Computational Intelligence in Medical Decision Making and Diagnosis Techniques and Applications", CRC Press, 2023
3. Melanie Mitchell, "An Introduction to Genetic Algorithms," MIT Press, 2000
4. James M. Keller, Derong Liu, David B. Fogel, "Fundamentals of Computational Intelligence: Neural Networks, Fuzzy Systems, and Evolutionary Computation", John Wiley & Sons, 2016
5. Sudharsan Ravichandiran, "Getting Started with Google BERT, Build and train state-of-the-art natural language processing models using BERT", Packt Publishing, 2021, ISBN 9781838826239
6. Mitchell Melanie, "An Introduction to Genetic Algorithms", The MIT Press Cambridge, Massachusetts, MIT Press paperback edition, 1998
7. Xin-She Yang, "Nature-Inspired Metaheuristic Algorithms", 2nd edition, University of Cambridge, United KingdomLuniversity Press

MOOC Courses:

1. Fuzzy Sets, Logic and Systems & Applications, IIT Kanpur: https://nptel.ac.in/courses/108104157
2. Fuzzy Logic and Neural Networks: https://youtu.be/xwUKQcT1bKc
3. Evolutionary Computation for Single and Multi-Objective Optimization: https://onlinecourses.nptel.ac.in/noc21_me43/preview
4. Traditional and Non-Traditional Optimization Tools ,IIT Kharagpur: https://nptel.ac.in/courses/112105235
5. Introduction to Soft Computing, IIT Kharagpur: https://nptel.ac.in/courses/106105173
6. Applied Natural Language Processing, Chennai Mathematical Institute: 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	3	2	1	2	-	-	-	-	-	-	-	-
CO2	3	2	2	2	1	-	-	-	-	-	-	-
CO3	2	2	3	2	-	-	-	-	-	-	-	-
CO4	2	3	3	2	-	-	-	-	-	-	-	-
CO5	2	2	2	2	1	1	-	-	-	1	-	-
CO6	2	2	3	2	1	1	-	-	-	-	-	-

Savitribai Phule Pune University
Fourth Year of Computer Science and Design (2021Course)
Elective V 418252 (B): Software Defined Networks

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

Prerequisites Courses: Computer Networks (218255)

Companion Course: Laboratory Practice VI (418255)

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 role in 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 Networking solutions.
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_sietovan ie.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**

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

Savitribai Phule Pune University
Fourth Year of Computer Science and Design (2021Course)
418252(C): High Performance Computing

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

Prerequisites Courses: - Computer Networks (218255)

Companion Course: Laboratory Practice VI (418255)

Course Objectives:

- To understand different parallel programming models
- To analyze the performance and modeling of parallel programs
- To illustrate the various techniques to parallelize the algorithm
- To implement parallel communication operations.
- To discriminate CUDA Architecture and its components.
- To Understand Scope of Parallel Computing and its search algorithms.

Course Outcomes:

CO1: **Understand** various Parallel Paradigm
CO2: **Design and Develop** an efficient parallel algorithm to solve given problem
CO3: **Illustrate** data communication operations on various parallel architecture
CO4: **Analyze** and measure performance of modern parallel computing systems
CO5: **Apply** CUDA architecture for parallel programming
CO6: **Analyze** the performance of HPC applications

Course Contents

Unit I	Introduction to Parallel Computing	07 Hours

Introduction to Parallel Computing: Motivating Parallelism, **Modern Processor:** Stored-program computer architecture, General-purpose Cache-based Microprocessor architecture. **Parallel Programming Platforms:** Implicit Parallelism, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines. Levels of parallelism, **Models:** SIMD, MIMD, SIMT, SPMD, Data Flow Models, Demand-driven Computation, **Architectures:** N-wide superscalar architectures, multi-core, multi-

#Exemplar/Case Studies	Case study: Multi-core System
***Mapping of Course Outcomes for Unit I**	CO1

Unit II	Parallel Algorithm Design	07 Hours

Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, **Parallel Algorithm Models:** Data, Task, Work Pool and Master Slave Model, **Complexities:** Sequential and Parallel Computational Complexity, Anomalies in Parallel Algorithms.

#Exemplar/Case Studies	Foster's parallel algorithm design methodology. (http://compsci.hunter.cuny.edu/~sweiss/course_materials/csci493.65/lecture_notes/chapter03.pdf)

***Mapping of Course Outcomes for Unit II**	CO2	
Unit III	**Parallel Communication**	**07 Hours**
Basic Communication: One-to-All Broadcast, All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Collective **Communication using MPI:**Scatter, Gather, Broadcast, Blocking and non blocking MPI, All-to-All Personalized Communication, Circular Shift, Improving the speed of some communication operations.		
#Exemplar/Case Studies	Monte-Carlo Pi computing using MPI	
***Mapping of Course Outcomes for UnitIII**	CO3	
Unit IV	**Analytical Modeling of Parallel Programs**	**07 Hours**
Sources of Overhead in Parallel Programs, **Performance Measures and Analysis:** Amdahl's and Gustafson's Laws, Speedup Factor and Efficiency, Cost and Utilization, Execution Rate and Redundancy, The Effect of Granularity on Performance, Scalability of Parallel Systems, Minimum Execution Time and Minimum Cost, Optimal Execution Time, Asymptotic Analysis of Parallel Programs. **Matrix Computation:** Matrix-Vector Multiplication, Matrix-Matrix Multiplication.		
#Exemplar/Case Studies	The DAG Model of parallel computation	
***Mapping of Course Outcomes for UnitIV**	**CO4**	
Unit V	**CUDA Architecture**	**07 Hours**
Introduction to GPU: Introduction to GPU Architecture overview, Introduction to CUDA C-CUDA programming model, write and launch a CUDA kernel, Handling Errors, CUDA memory model, Manage communication and synchronization, Parallel programming in CUDA- C.		
#Exemplar/Case Studies	GPU applications using SYCL and CUDA on NVIDIA	
***Mapping of Course Outcomes for Unit V**	CO5	
Unit VI	**High Performance Computing Applications**	**07 Hours**
Scope of Parallel Computing, **Parallel Search Algorithms:** Depth First Search(DFS), Breadth First Search(BFS), **Parallel Sorting:** Bubble and Merge, **Distributed Computing:** Document classification, Frameworks – Kuberbets, GPU Applications, Parallel Computing for AI/ ML		
#Exemplar/Case Studies	Disaster detection and management/ Smart Mobility/Urban planning	
***Mapping of Course Outcomes for Unit VI**	CO6	

Learning Resources

Text Books:

1. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, "Introduction to Parallel Computing", 2nd edition, Addison-Wesley, 2003, ISBN: 0-201-64865-2
2. Seyed H. Roosta, "Parallel Processing and Parallel Algorithms Theory and Computation‖", Springer-Verlag 2000 ,ISBN 978-1-4612-7048-5 ISBN 978-1-4612-1220-1
3. John Cheng, Max Grossman, and Ty McKercher, "Professional CUDA C Programming", John Wiley & Sons, Inc., ISBN: 978-1-118-73932-7

Reference Books :

1. Kai Hwang,, "Scalable Parallel Computing", McGraw Hill 1998.
2. George S. Almasi and Alan Gottlieb, "Highly Parallel Computing", The Benjamin and Cummings Pub. Co., Inc
3. Jason sanders, Edward Kandrot, "CUDA by Example", Addison-Wesley, ISBN-13: 978-0-13-138768-3
4. Pacheco, Peter S., "An Introduction to Parallel Programming", Morgan Kaufmann Publishers ISBN 978-0-12-374260-5
5. Rieffel WH.EG, Polak, "Quantum Computing: A gentle introduction", MIT Press, 2011,ISBN 978-0-262-01506-6
6. Ajay D. Kshemkalyani , Mukesh Singhal, "Distributed Computing: Principles, Algorithms, and Systems", Cambridge March 2011, ISBN: 9780521189842

e Books :

1. http://prdrklaina.weebly.com/uploads/5/7/7/3/5773421/introduction_to_high_performance_computing_for_scientists_and_engineers.pdf
2. https://www.vssut.ac.in/lecture_notes/lecture1428643084.pdf

NPTEL/YouTube video lecture link

- https://nptel.ac.in/courses/106108055
- https://www.digimat.in/nptel/courses/video/106104120/L01.html

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science & Design (2021Course)
Elective V 418252(D): DevOps

Teaching Scheme	Credit Scheme	Examination Scheme
Theory (TH): 3 hrs/week	03 Credits	Mid_Semester: 30 Marks End_Semester: 70 Marks

Prerequisite Courses: Software Engineering and Project Management(318241),Cloud Computing(318254)

Companion Course if any: Laboratory Practice VI (418255)

Course Objectives:

1. To understand the need of DevOps as a software engineering practice.
2. To understand the background of DevOps Evolution.
3. To know and understand the concept of Continuous Integration Continuous Delivery (CICD).
4. To learn the concept of continuous deployment and test strategies.
5. To learn the monitoring system and reliability engineering.
6. To explore the emerging tools used in the DevOps lifecycle.

Course Outcomes:

On completion of the course, students will be able –

CO1. Understand the fundamental concepts of DevOps
CO2. Link the background of DevOps with other technologies
CO3. Comprehend the concept of continuous integration and continuous delivery
CO4. Compare various stages of continuous deployment and test strategies
CO5. Justify the importance of monitoring system and reliability engineering
CO6. Use the latest tools in DevOps

COURSE CONTENTS

Unit I	Introduction to DevOps and the Culture	(7hrs)

What is DevOps? Role of DevOps Engineer, Developer responsibility, Introduction to Continuous Integration and Continuous Delivery Policies, DevOps Culture: Dilution of barriers in IT departments, Process automation, Agile Practices, Reason for adopting DevOps, What and Who Are Involved in DevOps? Changing the Coordination, Introduction to DevOps pipeline phases, Defining the Development Pipeline, Centralizing the Building Server, Monitoring Best Practices, Best Practices for

Mapping of Course Outcomes for Unit I	CO1

Unit II	Microservices Architecture and Cloud Native Development	(7hrs)

Monolithic applications, Introduction to microservice architecture, Implementing a microservices Architecture, Pros and Cons of a microservice Architecture, Characteristics of microservice architecture, Monolithic applications and microservices compared, microservices best practices, Deployment strategies, Introduction to cloud computing, cloud computing deployment models, service models, why to use cloud, Principle of container based application design, Introduction to Docker, Serverless computing, orchestration, Difference between orchestration and automation		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Continuous Integration and Test-Driven Development**	**(7 hrs)**
Introduction to continuous integration, time to market and quality, Build in a Continuous Integration Scenario, Code Repository Server, Continuous Integration Server, Introduction to Continuous Delivery and chain, Differentiate Continuous Integration and Continuous Delivery, Strategies for Continuous Delivery, Benefits of Continuous Integration and Continuous Delivery, Designing a CI and CD System, Building Continuous Integration and Continuous Delivery Pipelines, Continuous Database Integration, Preparing the Build for Release, Identifying the Code in the Repository, Creating Build Reports, Putting the Build in a Shared Location, Releasing the Build		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Continuous Deployment and Orchestration**	**(7hrs)**
Implementing a testing Strategy: Types of Tests, Integration testing, managing defect backlogs, what is Continuous Deployment? Changes moving through the deployment pipeline, Trade-offs in the deployment pipeline, Basic Deployment pipeline, Deployment pipeline practices & Commit stage, Automated Acceptance Test Gate, Subsequent test stages, preparing to release, Implementing a deployment pipeline		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Continuous Monitoring and Site Reliability**	**(7 hrs)**
What is a monitoring system? Factors involved in monitoring systems, why monitoring is important, white-box and black-box monitoring, building a monitoring system, monitoring infrastructure and applications, collecting data, logging, creating dashboard, behavior driven monitoring, what is site reliability engineering? SRE and DevOps, roles, and responsibilities of SRE, common tools used by SREs		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**DevOps Tooling and Case Studies**	**(7 hrs)**

Continuous Development/ Version Control: Git, Serverless orchestration: Kubernetes, Container Technology: Docker, Continuous Integration: Jenkins, Continuous delivery: Jenkins, Continuous Deployment: Ansible, Continuous Testing: Selenium, Monitoring: Prometheus, Bug tracking tool: Jira, elk stack. Case study: Spotify: Using Docker, Bank of New Zealand, EtSy.

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

Textbooks:

1. Pierluigi Riti, "Pro DevOps with Google Cloud Platform", Apress, ISBN: 978-1-4842-3896-7.

2. Katrina Clokie, "A Practical Guide to Testing in DevOps", Lean Publishing published on 2017-08-01

3. Jez Humble and David Farley, "Continuous Delivery", Pearson Education, Inc, ISBN: 978–0–321–60191–9

Reference Books:

1. Viktor Farcic, "The DevOps 2.0 Toolkit: Automating the Continuous Deployment Pipeline with Containerized Microservices"

2. Jennifer Davis and Katherine Daniels, "Effective DevOps: Building a Culture of Collaboration, Anity, and Tooling at Scale", O'Reilly Media, Inc., ISBN: 978-1-491-92630-7

3. Sanjeev Sharma and Bernie Coyne, "DevOps for Dummies", John Wiley & Sons, Inc., 2nd IBM Limited Edition, ISBN: 978-1-119-04705-6

Web Links:

1. https://www.redhat.com/en/resources/cloud-native-container-design-whitepaper
2. https://www.redhat.com/en/topics/cloud-native-apps/what-is-serverless
3. https://www.redhat.com/en/topics/automation/what-is-orchestration
4. https://www.atlassian.com/continuous-delivery/continuous-integration
5. https://www.flagship.io/glossary/site-reliability-engineer/
6. https://docs.microsoft.com/en-us/learn/paths/intro-to-vc-git/

CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science and Design(2021Course)
Elective VI 418253(A): Data Visualization

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), Computer Vision (418241)

Companion Course: Laboratory Practice VI (418255)

Course Objectives:

- To understand the various types of data, apply and evaluate the principles of data visualization.
- Acquire skills to apply visualization techniques to a problem and its associated dataset.
- To apply structured approach to create effective visualizations from the massive
- dataset using various visualization tools.

Course Outcomes:

1. Understand the key techniques and theory behind data visualization
2. Analyze the different data types, visualization types to bring out the insight.
3. Relate the visualization towards the problem based on the dataset to analyze and bring out valuable insight on large dataset.
4. Design visualization dashboard to support the decision making on large scale data.
5. Demonstrate the analysis of large dataset using various visualization techniques and tools
6. Evaluate information visualization systems and other forms of visual presentation for their effectiveness

Course Contents

Unit I	Introduction to Data Visualization	07 Hours

Overview of data visualization - Data Abstraction - Task Abstraction - Dimensions and Measures - Analysis: Four Levels for Validation. Statistical charts (Bar Chart - stacked bar chart – Line Chart - Histogram - Pie chart - Frequency Polygon - Box plot - Scatter plot - Regression curves.)

*Mapping of Course Outcomes for Unit I	CO1

Unit II	Visualization tools and techniques	07 Hours

Introduction to various data visualization tools - Scalar and point techniques - vector visualization techniques - multidimensional techniques - visualizing cluster analysis – K-means and Hierarchical Cluster techniques,, Matrix visualization in Bayesian data analysis, Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications

*Mapping of Course Outcomes for Unit II	CO2

Unit III	Spatio temporal visualization	07 Hours

Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization, Time Series data visualization – Text data visualization – Spatial Data Visualization

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

Unit IV	**Visual Analytic**	**07 Hours**

Networks and Trees - Heat Map – Tree Map - Map Color and Other Channels Manipulate View - Visual Attributes

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

Unit V	**Multivariate Data Visualization**	**07 Hours**

Multivariate data visualization – Geometric projection techniques - Icon-based techniques - Pixel-oriented techniques - Hierarchical techniques - Scatterplot matrix - Hyper box - Trellis display - Parallel coordinates

***Mapping of Course Outcomes for Unit V**	CO5

Unit VI	**Data Visualization Tools and dashboard**	**07 Hours**

Tableau functions and logics: Marks and Channels-Arrange Tables- Arrange Spatial Data- Facets into multiple views, Data Dashboard- Taxonomies- User Interaction- Organizational Functions-Dashboard Design – Worksheets - Workbooks – Workbook Optimization - Protection and common mistakes Dashboard creation using visualization tool use cases: Finance-marketing-insurance-healthcare

Mapping of Course Outcomes for Unit V	CO6

Learning Resources

Text Books:

1. Matthew O. Ward, Georges Grinstein, Daniel Keim, "Interactive Data Visualization: Foundations, Techniques, and Applications", 2nd Edition, CRC press, 2015
2. Tamara Munzer, Visualization Analysis and Design, 1st edition, CRC Press, United States, 2015.
3. Michael Fry, Jeffrey Ohlmann, Jeffrey Camm, James Cochran, Data Visualization: Exploring and Explaining with Data, South-Western College Publishing, 2021

Reference Books:

1. Dr. Chun-hauh Chen, W. K. Hardle, A. Unwin, Handbook of Data Visualization, 1st edition, Springer publication, Germany, 2008.
2. Ben Fry, Visualizing Data, 1st edition, O'Reilly Media, United States, 2008.
3. Avril Coghlan, A little book of R for multivariate analysis, 1st edition, Welcome Trust Sanger Institute, United Kingdom, 2013
4. Clous O.Wilke, "Fundamentals of Data Visualization - A Primer on Making Informative and Compelling Figures", O'Reilly Media, Inc.
5. Kieran Healy, "Data Visualization - A Practical Introduction"

MOOC Courses Links:

- https://freevideolectures.com/course/4041/nptel-introduction-to-learning-analytics/11

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

Savitribai Phule Pune University
Fourth Year of Computer Science and Design(2021Course)
Elective VI 418253(B): Optimization Algorithm

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), Data Structures and Algorithms (218242)

Companion Course: Laboratory Practice VI (418255)

Course Objectives:

- To understand the need of optimization Algorithms
- To apply the optimization techniques while solving the problems
- To understand the constraints applied and optimization of the algorithm
- To optimize searching strategies
- To understand and use Self Optimizing algorithms

Course Outcomes:

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

CO1: Identify Optimization Concepts to incorporate in problem solving in effective way
CO2: To formulate given optimization problem mathematically precisely
CO3: To create model using Optimization Techniques, like linear programming, integer programming and dynamic programming
CO4: To select an optimization strategy to tackle complex optimization problems and evaluate the optimization algorithms
CO5: To distinguish strategies of Optimization Algorithms selected
CO6: To construct an Optimization strategy to solve different problems

Course Contents

Unit I	Introduction	07 Hours

Introduction, Fundamentals of Optimization, general structure of the optimization algorithms, types of optimization problems, examples of optimization, formulation of optimization problem, classification of optimization algorithms, traveling salesman and knapsack problem

#Exemplar/Case Studies	Analyze the traveling salesman problem for optimization
*Mapping of Course Outcomes for Unit I	CO1

Unit II	Classical Optimization	07 Hours

Introduction, Mathematical model of optimization, Optimality conditions, **Solution techniques**- Penalty function, Linear programming (LP)-Formulation of LP Problem Optimality conditions, Integer Linear Programming, LP duality-Farkas Lemma, **Quadratic Programming (QP)**-Convex QP problems, Convex Programming, general constraint optimization problem

#Exemplar/Case Studies	Solve the Multistage Graph Problem with Dynamic Programming
*Mapping of Course Outcomes for Unit II	CO2

Unit III	Constraint Optimization	07 Hours
Introduction **Linear Programming**-Simplex Method, Revised Simplex Method, Karmarkar's Method, Duality Theorem and Transportation Problem, **Non-linear Programming**-Quadratic and Geometric Programming, Karush–Kuhn–Tucker (KKT) conditions test as necessary condition. **Dynamic Programming**- Continuous vs Discrete dynamic programming, multistage graph problem, traveling salesman and knapsack problem		
#Exemplar/Case Studies	Solving linear equations with Genetic Algorithms	
***Mapping of Course Outcomes for Unit III**	CO3	
Unit IV	**Search Optimization**	**07 Hours**
Introduction, **Genetic Algorithms**-Initialize population, Fitness Evaluation, Reproduction, Crossover and Mutation, Multimodel test function, Solving linear equations with genetic algorithm, **Simulated Annealing(SA)**-Annealing and Boltzmann Distribution, Parameters, SA Algorithm, Unconstrained Optimization, Basic Convergence Properties, SA Behavior in Practice and Stochastic Tunneling, **Particle Swarm Optimization(PSO)**-Introduction, Swarm Behavior, PSO Algorithm, Variants of PSO Algorithm		
#Exemplar/Case Studies	Penalty function implementation in convex computation	
***Mapping of Course Outcomes for Unit IV**	CO4	
Unit V	**Differential Evolution and Swarm Optimization**	**07 Hours**
Introduction, **Differential Evolution**-Introduction, Differential Evolution, Variants, Choice of Parameters Convergence Analysis and Implementation. **Swarm Optimization**-Swarm Intelligence, PSO Algorithm, Accelerated PSO, Convergence Analysis-PSO, Binary PSO, **Multiobjective Optimization**- Pareto Optimality, Constraint Methods, Weight Methods, Preference Elicitation, Ant colony optimization(ACO)		
#Exemplar/Case Studies	Binary PSO implementation	
***Mapping of Course Outcomes for Unit V**	CO5	
Unit VI	**Self Tuning Algorithms**	**07 Hours**
Introduction, Algorithm Analysis and Parameter Tuning, Framework for Self-Tuning Algorithms, **A Self-Tuning Firefly Algorithm**- Firefly Behavior, Standard Firefly Algorithm, Variations of Light Intensity and Attractiveness, Controlling Randomization Variants of the Firefly Algorithm, Firefly Algorithms in Applications, **Bat Algorithm**- Echolocation of Bats, Bat Algorithms, Binary Bat Algorithms, Convergence Analysis, Applications		
#Exemplar/Case Studies	Implementation of Firefly algorithm to understand the self tunning	
***Mapping of Course Outcomes for Unit VI**	CO6	

Learning Resources

Text Books:

1. Andreas Antoniou, Wu-Sheng Lu, "Practical optimization algorithms and engineering applications", Springer, 2007
2. Vasuki A., "Nature Inspired Optimization Algorithms", CRC Press, 2020
3. Mykel J. Kochenderfer, Tim A. Wheeler, "Algorithms for Optimization", MIT Press, 2019

Reference Books:

1. Rajesh Kumar Arora, "Optimization Algorithms and Applications", Chapman & Hall, CRC, 2015
2. A Schrijver, "Theory of Linear and Integer Programming" (Wiley Series in Discrete Mathematics & Optimization)
3. V. Chvatal, "Linear Programming"

MOOC Courses:

1. **https://www.coursera.org/learn/optimization-for-decision-making**
2. **https://www.coursera.org/learn/solving-algorithms-discrete-optimization**

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science & Design (2021Course)
Elective VI 418253(C): GPU Programming and Architecture Design

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

Prerequisites Courses: Computer Graphics (210244)

Companion Course: Laboratory Practice VI (418255)

Course Objectives:

- To understand Graphics Processing Unit (GPU) architecture
- To understand the basics of CUDA programming
- To write programs for massively parallel processors
- To understand the issues in mapping algorithms for GPUs
- To introduce different GPU programming models
- To optimize and evaluate the performance of modern GPUs

Course Outcomes:

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

CO1: Describe GPU architecture

CO2: Apply CUDA architecture for parallel programming **CO3:** Analyze programming issues in CUDA programming **CO4:** Acquire proficiency in programming GPUs using OpenCL

CO5: Identify efficient parallel programming patterns to solve problems

CO6: Apply programming skills that make efficient use of the GPU processing power

Course Contents

Unit I	Introduction to GPU Architecture	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**	CO1

Unit II	CUDA Programming	07 Hours

Benefits of using GPU, CUDA-A General-Purpose Parallel Computing Platform and Programming Model, A scalable Programming Model, Programming Model - Kernels, Thread Hierarchy, Memory Hierarchy, Heterogeneous Programming, Asynchronous SIMT Programming Model, Compute Capability, Using CUDA – Multi CPU – Multi GPU Solutions, **Optimizing CUDA Applications:** Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions

#Exemplar/Case Studies	GPU applications using SYCL and CUDA on NVIDIA

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

Unit III	**CUDA Programming Issues**	**07 Hours**

Common Problems: CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors. Compilation with NVCC-Compilation Workflow, Binary Compatibility, PTX Compatibility, Application Compatibility, C++Compatibility, 64-bit Compatibility, CUDA Runtime

#Exemplar/Case Studies	Image feature extraction algorithm based on CUDA architecture
***Mapping of Course Outcomes for Unit III**	CO3

Unit IV	**Introduction to OpenCL Programming**	**07 Hours**

The basic ideas of OpenCL programs, what kind of parallel programming model is OpenCL? Common tasks of OpenCL host programs, alternatives to OpenCL for GPU programming? OpenCL Standard – Kernels – Host Device Interaction – Execution Environment – Memory Model– Basic OpenCL Examples

#Exemplar/Case Studies	Exploiting Task Parallelism with OpenCL
***Mapping of Course Outcomes for Unit IV**	CO4

Unit V	**Algorithms on GPU**	**07 Hours**

Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix – Matrix Multiplication – Programming Heterogeneous Cluster, Performance- Synchronization, Dynamic-parallelism-enabled Kernel Overhead, Implementation, Restrictions, and Limitations- Runtime-Memory Footprint, Nesting and Synchronization Depth, Pending Kernel Launches, Configuration Options, Memory Allocation and Lifetime.

#Exemplar/Case Studies	Accelerating genetic algorithms with GPU computing: A selective overview
***Mapping of Course Outcomes for Unit V**	CO5

Unit VI	**OpenCL and Application Design**	**07 Hours**

OpenCL Platform Model, OpenCL Memory Model, Application Specific Processors (ASP), Transport Triggered Architecture (TTA), Practical Issues in compiling OCL Standalone Execution of OpenCL Applications, OpenCL for Heterogeneous Computing, **Application Design**: Efficient Neural Network Training/Inferencing

#Exemplar/Case Studies	GPU-Accelerated Cone-Beam CT
***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)", 1st 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, LeeHowes, David R. Kaeli, "Heterogeneous Computing with OpenCL", 2012

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 GPU Programming", Addison – Wesley, 2010
3. David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors, A Hands-on Approach", 3rd edition, Morgan Kaufmann, 2016
4. CUDA C++ Programming Guide https://docs.nvidia.com/cuda/cuda-c-programming-guide/index.html#compilation-with-nvcc
5. CUDA Toolkit https://developer.nvidia.com/cuda-zone
6. OpenCL http://www.openCL.org

e-Resources:

1. https://edoras.sdsu.edu/~mthomas/docs/cuda/cuda_by_example.book.pdf
2. https://www.cs.utexas.edu/~rossbach/cs380p/papers/cuda-programming.pdf
3. https://www.syncfusion.com/succinctly-free-ebooks/confirmation/cuda
4. https://ptgmedia.pearsoncmg.com/images/9780321749642/samplepages/0321749642.pdf

MOOC Courses:

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

The CO-PO Mapping Matrix

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

Savitribai Phule Pune University
Fourth Year of Computer Science & Design (2021Course)
Elective VI 418253 (D): Mobile Computing

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

Prerequisites Courses: Computer Networks (218255)

Companion Course: Laboratory Practice VI (418255)

Course Objectives:

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

Course Outcomes:

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

Course Contents

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 and LR VLR and HLR Failure restoration, VLR identification algorithm, O-I, O-II algorithm etc. Overview of handoff process; Factors affecting handoffs and performance evaluation metrics; Handoff strategies; Different types of handoffs (soft, hard, horizontal, vertical).		
#Exemplar/Case Studies	5G Mobility Management , Micro Mobility: Cellular IP, 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	**3G and 4G Technologies**	**07 Hours**

3G and 4G Technologies for GSM and CDMA:, W-CDMA, UMTS, HSPA (High Speed Packet Access), HSDPA, HSUPA, HSPA+, TD-SCDMA, LTE (E-UTRA) 3GPP2 family CDMA2000 1x, 1xRTT, EV-DO (Evolution-Data Optimized), Long Term Evolution (LTE) in 4G. Architecture of 5G. Role of 5G in IoT.	
#Exemplar/Case Studies	Long-Term Evolution (LTE) of 3GPP
***Mapping of Course Outcomes for Unit VI**	CO6

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 Mobile Communications‖, Wiley publications
3. Andrea Goldsmith, –Wireless Communications‖, Cambridge University Press, 2012.

e-Books :

1. http://www.dauniv.ac.in/downloads/Mobilecomputing/Microsoft%20%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, Pune
Fourth Year of Computer Science & Design (2021Course)
418254: Laboratory Practice V

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

Companion Course: Information and Cyber Security (418250), Generative AI(418251)

- **Course Objectives:**

  - To offer an understanding of principle concepts, central topics and basic approaches in information and cyber security.
  - To know the basics of cryptography.
  - To acquire knowledge of standard algorithms and protocols employed to provide confidentiality, integrity and authenticity.
  - To understand the fundamentals of Generative Adversarial Networks (GANs)
  - .To acquire knowledge on how to use Generative AI techniques in software development.
  - To understand language model architectures, training methods.
  - To study the role of prompt engineering in NLP model development.

Course Outcomes:

Gauge the security protections and limitations provided by today's technology.
CO1: Identify cyber security threats.
CO2: Analyze threats in order to protect or defend it in cyberspace from cyber-attacks.
CO3: Build appropriate security solutions against cyber-attacks
CO4 :Understand generative AI, including its underlying principles, techniques, and applications.
CO5: Understand language model their architecture and applications
CO6:Explain the fundamentals of deep generative models

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

Guidelines for Practical Examination

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

Guidelines for Laboratory Conduction

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

Software Engineering approach with proper documentation is to be strictly followed.

- Use of open source software is to be encouraged.
- Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.

- Operating System recommended:- 64-bit Open source Linux or its derivative
- Programming Languages: C++/JAVA/PYTHON/R
- Programming tools recommended: Pytorch Tensorflow , keras ,numpy , pretrained models, Datasets etc

Suggested List of Laboratory Experiments/Assignments

418250: Information and Cyber Security

Any 4 Assignments and 1 Mini Project are Mandatory

Group 1	
1.	Implementation of S-DES
2.	Implementation of S-AES
3.	Implementation of Diffie-Hellman key exchange
4.	Implementation of RSA
5.	Implementation of ECC algorithm.
6.	Enable/Configure (windows/ubuntu) firewall. Create rules to filter network traffic and to block unauthorized network traffic.
7.	Configure and demonstrate an Intrusion Detection System (IDS) to detect suspicious activities and generate alerts when detected.
Group 2	
8	Mini Project 1:: Implement Cross Site Scripting using stored attack. A stored cross-site scripting vulnerability in the comment functionality. [Note: To implement this assignment, submit a comment that calls the alert function when the blog post is viewed.]
9	Mini Project 2: Implement SQL injection vulnerability attack that causes the application to display details of all the products available on website.
10	Mini Project 3: Design the Access control vulnerability. [Note: This assignment has an unprotected admin panel. It is located at an unpredictable location, but the location is disclosed somewhere in the application. Use https://portswigger.net]
11	Mini Project 4: This task is to demonstrate insecure and secured website. Develop a web site and demonstrate how the contents of the site can be changed by the attackers if it is http based and not secured. You can also add payment gateway and demonstrate how money transactions can be hacked by the hackers. Then support your website having https with SSL and demonstrate how secured website is.

418251 : Generative AI

4 Assignments and 1 Mini Project are Mandatory

Group 1	
1	Implementing a simple GAN architecture using a deep learning framework like TensorFlow or PyTorch.Train the GAN on a basic dataset such as MNIST (handwritten digits) or Fashion-MNIST (clothing items).Experiment with different architectures, loss functions, and training parameters to observe their effects on the generated images.
2	Building and training a very simple LLM from scratch.
3	Generate an AI- Image using DALL·E 2 API using Python .

4	Use Open AI API to craft a perfect AI Image Prompt
5	Music Generation with Recurrent Neural Networks (RNNs) Build a recurrent neural network (RNN) model for generating music sequences. Train the RNN on a dataset of MIDI files containing musical compositions. Generate new music sequences by sampling from the trained model and listen to the resulting compositions.
6	Generate Captions for Images with a Pretrained Image Captioning Model Utilize a pretrained image captioning model like Show and Tell or Transformers for image captioning tasks. Input images from a dataset like MS COCO and generate descriptive captions for each image. Evaluate the generated captions in terms of relevance and coherence with the corresponding images.
Group 2 Mini Project Implement using Tensorflow and Pytorch	
5	Implementing a Basic Generative Adversarial Network (GAN):
6	Conditional Image Generation with Conditional Generative Models:
`7	Image Style Transfer with Neural Style Transfer

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

Savitribai Phule Pune University
Fourth Year of Computer Science & Design (2021Course)
418255: Laboratory Practice VI

Teaching Scheme: Practical: 2 Hrs/Week	Credit 01	Examination Scheme : Term Work: 25 Marks Oral: 25 Marks

Companion Course: Elective V (418252), Elective VI (418253)

Course Objectives:

- To understand the fundamental concepts and techniques of computational intelligence
- To understand high performance computing architecture
- To learn the fundamentals of software defined networks
- To be familiar with the various application areas of soft computing.
- To study DevOps and cloud fundamentals

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, power BI

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

Guidelines for Laboratory /Term Work Assessment

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

Guidelines for Practical Examination

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

Guidelines for Laboratory Conduction

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

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

Suggested List of Laboratory Experiments/Assignments

418252 (A): Computational Intelligence

4 Assignments and 1 Mini Project are Mandatory

Group 1

1.	To apply the artificial immune pattern recognition to perform a task of structure damage Classification
2.	Optimization of genetic algorithm parameter in hybrid genetic algorithm-neural network modelling: Application to spray drying of coconut milk
3.	Implement Ant colony optimization by solving the Traveling salesman problem using python Problem statement- A salesman needs to visit a set of cities exactly once and return to the original city. The task is to find the shortest possible route that the salesman can take to visit all the cities and return to the starting city.
4.	Choose an optimization problem: Select a simple optimization problem to solve using a genetic algorithm. This could be a classic problem like the knapsack problem
5.	Implement crossover operators such as single-point crossover, two-point crossover, or uniform crossover to create offspring from selected parents.
6.	Text Classification with Bag of Words

Group 2 Mini Project

8	Implement DEAP (Distributed Evolutionary Algorithms) using Python
9	Implement Ant colony optimization by solving the Traveling salesman problem using python Problem statement- A salesman needs to visit a set of cities exactly once and return to the original city. The task
10	To apply the artificial immune pattern recognition to perform a task of structure damage Classification.

418252 (B): Software Defined Networks

Any 4 Assignments and 1 Mini Project are Mandatory

Group 1

1.	Prepare setup for Mininet network emulation environment with the help of Virtual box and Mininet. Demonstrate the basic commands in Mininet and emulate different custom network topology(Simple, Linear, and Tree).View flow tables.
2.	After studying open source POX and Floodlight controller, Install controller and run custom topology using remote controller like POX and floodlight controller. Recognize inserted flows by controllers.
3.	Create a SDN environment on Mininet and configure a switch to provide a firewall functionality using POX controller. Ref: 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/SimpleRoute**
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 Cloud Seeds automates IaaS using SDN and a high performance network from Juniper SDN Fra
418252 (C): High Performance Computing	
Any 4 Assignments and 1 Mini Project are Mandatory	
Group 1	
1.	Design and implement Parallel Breadth First Search and Depth First Search based on existing algorithms using OpenMP. Use a Tree or an undirected graph for BFS and DFS .
2.	Write a program to implement Parallel Bubble Sort and Merge sort using OpenMP. Use existing algorithms and measure the performance of sequential and parallel algorithms.
3.	Implement Min, Max, Sum and Average operations using Parallel Reduction
4.	Write a CUDA Program for : 1. Addition of two large vectors 2. Matrix Multiplication using CUDA C
5	Implement HPC application for AI/ML domain.
Group 2 Mini Project:	
6.	Mini Project: Evaluate performance enhancement of parallel Quicksort Algorithm using MP
7	Mini Project: Implement Huffman Encoding on GPU
8	Mini Project: Implement Parallelization of Database Query optimization
8	Mini Project: Implement Non-Serial Polyadic Dynamic Programming with GPU Parallelization
418252 (D): Devops	
Any 4 Assignments and 1 Mini Project are Mandatory	
Group 1	
1.	Use Version Control System for a document/program (check in/check out/update/pull/push modifications, create tags/branches)
2.	Build a prototype of an application using tools (such as Maven). Prepare unit test case and execute

3.	Using Continuous Integration (CI)/Continuous Deployment (CD) automation tool (Jenkins), build pipeline. Integrate build stage. Integrate/API test stage with pipeline.
4.	Test the prototype/application using Integration tests Using Continuous Integration (CI)/Continuous Deployment (CD) automation tool(Jenkins), build pipeline. Integrate build stage. Integrate/API test stage with pipeline.
5	Set up DevOps environment for CI, CD (creation of non-root account, S3 bucket, IAM Role, attach policies, secret keys) Integrate Jenkins with DevOps environment (secret keys exchange)
Group 2	**Mini Project**
5.	Deploy the application, run and troubleshoot
6.	Define Jenkins pipeline incorporating, build, test and deploy (publish) stages – I Define Jenkins pipeline incorporating, build, test and deploy (publish) stages - II
418253 (A): Data Visualization	
Any 4 Assignments and 1 Mini Project are Mandatory	
Group 1	
1.	**Data Visualization using matplotlib** **Problem Statement:** Analyzing Air Quality Index (AQI) Trends in a City **Dataset**: "City_Air_Quality.csv" **Description:** The dataset contains information about air quality measurements in a specific city over a period of time. It includes attributes such as date, time, pollutant levels (e.g., PM2.5, PM10, CO), and the Air Quality Index (AQI) values. The goal is to use the matplotlib library to create visualizations that effectively represent the AQI trends and patterns for different pollutants in the city. **Tasks to Perform:** 1. Import the "City_Air_Quality.csv" dataset. 2. Explore the dataset to understand its structure and content. 3. Identify the relevant variables for visualizing AQI trends, such as date, pollutant levels, and
	4. Create line plots or time series plots to visualize the overall AQI trend over time. 5. Plot individual pollutant levels (e.g., PM2.5, PM10, CO) on separate line plots to visualize their trends over time. 6. Use bar plots or stacked bar plots to compare the AQI values across different dates or time periods. 7. Create box plots or violin plots to analyze the distribution of AQI values for different pollutant categories. 8. Use scatter plots or bubble charts to explore the relationship between AQI values and pollutant levels. Customize the visualizations by adding labels, titles, legends, and appropriate color schemes.

2	**Data Aggregation** **Problem Statement:** Analyzing Sales Performance by Region in a Retail Company **Dataset:** "Retail_Sales_Data.csv" **Description:** The dataset contains information about sales transactions in a retail company. It includes attributes such as transaction date, product category, quantity sold, and sales amount. The goal is to perform data aggregation to analyze the sales performance by region and identify the top-performing regions. **Tasks to Perform:** 1. Import the "Retail_Sales_Data.csv" dataset. 2. Explore the dataset to understand its structure and content. 3. Identify the relevant variables for aggregating sales data, such as region, sales amount, and product category. 4. Group the sales data by region and calculate the total sales amount for each region. 5. Create bar plots or pie charts to visualize the sales distribution by region. 6. Identify the top-performing regions based on the highest sales amount. 7. Group the sales data by region and product category to calculate the total sales amount for each combination. Create stacked bar plots or grouped bar plots to compare the sales amounts across different regions and product categories.
3	Financial analysis using Clustering, Histogram and HeatMap

4	**Time Series Data Analysis** **Problem statement: Analysis and Visualization of Stock Market Data** **Dataset:** "Stock_Prices.csv" **Description:** The dataset contains historical stock price data for a particular company over a period of time. It includes attributes such as date, closing price, volume, and other relevant features. The goal is to perform time series data analysis on the stock price data to identify trends, patterns, and potential predictors, as well as build models to forecast future stock prices. **Tasks to Perform:** 1. Import the "Stock_Prices.csv" dataset. 2. Explore the dataset to understand its structure and content. 3. Ensure that the date column is in the appropriate format (e.g., datetime) for time series analysis. 4. Plot line charts or time series plots to visualize the historical stock price trends over time. 5. Calculate and plot moving averages or rolling averages to identify the underlying trends and smooth out noise. 6. Perform seasonality analysis to identify periodic patterns in the stock prices, such as weekly, monthly, or yearly fluctuations. 7. Analyze and plot the correlation between the stock prices and other variables, such as trading volume or market indices. Use autoregressive integrated moving average (ARIMA) models or exponential smoothing models to forecast future stock prices.
5	Geo spatial data visualization • Visualize the loaded geospatial data using basic plotting functions provided by **geopandas**. • Plot the geometries (e.g., polygons, points) contained in the dataset on a map. • install necessary Python libraries for geospatial data visualization, such as **geopandas**, **matplotlib**, and **folium**.
6	• Set up a Jupyter Notebook or Python environment for conducting the assignment. Statistical Analysis – such as Multivariate Analysis, PCA, LDA, Correlation regression and analysis of variance
Group 2	**Mini Project**
1	Customized Visualization: use datasets and perform • Customize the visualization by adjusting the appearance of the plot (e.g., colors, markers, sizes) to make it more informative and visually appealing.
2	• Add labels, legends, and other annotations to enhance the interpretation of the map. **Interactive Visualization with Folium:** • Use the **folium** library to create an interactive map visualization. • Add interactive elements such as tooltips, popups, and layer controls to provide additional information and interactivity to the map.

418253 (B): Optimization Algorithm

Any 4 Assignments and 1 Mini Project are Mandatory

Group 1

1. A mechanical industry has three warehouses in the Solapur area and needs to deliver camshafts to its three shops in and around for tomorrow. The three shops demand 10, 20, and 40 units respectively. The current stock level of shafts in the three warehouses are 80, 62, and 32 respectively. Delivery costs from each warehouse to each store are different due to different distances. Find the least expensive way to deliver the chairs to the stores. The delivery cost matrix is represented below.

	Shop 1	Shop 2	Shop 3
Warehouse 1	3000/-	2000/-	5000/-
Warehouse 2	2000/-	7000/-	3000/-
Warehouse 3	2200/-	2400/-	1000/-

Use Linear Programming to write a program in python.

2. Write a python program to maximize the function $f(x) = 2x1 + 3x2 - x\ 2\ 1 + x2\ 2$ with constraints $x1 + x2 <= 3\ and\ 2x1 + 3x2 <= 4$ find out the values of $x1\ and\ x2$ such a that it maximizes the given objective function $f(x)$ using Quadratic Programming

3. Write a python program to minimize the flow from source S to the destination D in a multi-stage graph with a property $|v1| = |vn| = 1$, Here $v1$ and $v2$ are the partitions of the graph G and no connecting edge in the same partition. Find out a path from S to the D with minimum cost.

4. A linear equation of the form $aX1 + bX2 + cX3 + dX4 = T$ is to be solved with the help of Genetic Algorithms applying Initialize population, Fitness Evaluation, Reproduction, Crossover and Mutation. Find out the approximate values of the coefficients $a, b, c\ and\ d$ with python programming

5. There is a dataset D over $R\ mX$, supplied to the machine learning algorithm for classification purposes. We are cautious about the selection of the attributes for training and testing the model. Use Particle Swarm Optimization for feature section and show that the performance of a classification algorithm is improved over the use of PSO.

Group 2 Mini Project:

6 Mini Project: Design and develop a mini project for classification of images into different categories using CNN along with Particle Swarm Optimization/Firefly/Binary PSO. The group of students developing this application need to use different datasets. Priority must be given for self-data creation, publishing and using it in this project.**:**

418253 (C): GPU Programming and Architecture Design	
Any 4 Assignments and 1 Mini Project are 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:	
7.	Huge data computation
8.	Visualization to develop project for image processing and then video processing
9.	Parallel programming
418253 (D): Mobile Computing	
Any 4 Assignments and 1 Mini Project are 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 Mini Project:	
6.	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 for Provide different menu options
7.	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.	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

CO-PO Mapping Matrix												
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 & Design (2021Course)
418256: Project Work Stage II

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

Prerequisite Courses: Project Stage I (418248)

Course Objectives:

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

Course Outcomes:

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

CO1: Show evidence of independent investigation

CO2: Critically analyze the results and their interpretation.

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

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

CO5: Appreciate practical implications and constraints of the specialist subject

Guidelines

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

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

Savitribai Phule Pune University
Fourth Year of Computer Science and Design (2021 Course)
418257: Audit Course 8
AC8 – I: 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, Zoraida Callejas, 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–II: Social Media And Analytics

This course aims to create awareness among the students regarding social media and analytics.

Course Objectives:

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

Course Outcome:

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

CO1: Develop a far deeper understanding of the changing digital 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 (Wikipedia etc),Multi-media - Video (Video Streaming, YouTube etc),Multi-media - Audio & Podcasting (iTunes etc),Multi- media - Photos/Images (Flickr etc),Google Alerts and Giga Alert (Brand, product and service monitoring online),Crowd sourcing, Virtual Worlds.

3. Search Engine Optimization (SEO), Search Engine Optimization (SEO) tips and techniques, Google Adwords, Google various applications such as 'Google Analytics', Maps, Places etc to enhance a brand's products, services and operations.

4. Facebook & LinkedIn and other Social Media for areal marketing, Utilizing Facebook and LinkedIn's Advertising functionality and Applications, Brand reputation management techniques, Systems for 'buzz monitoring 'for brands, products and services, Effective Public Relations (PR) online and business

References:

1. Vandana Ahuja, "Digital Marketing", Oxford Press, 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 – III: 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 effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy. This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses.

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

Guidelines:

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

References:

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

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AC8 – IV: 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,” , Bantam Books, 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

Task Force Curriculum Design

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