Faculty of Science & Technology
Savitribai Phule Pune University
Pune, Maharashtra, India

Curriculum for
Final Year of Information Technology
(2019 Course)
(With effect from AY 2022-23)

INDEX

Savitribai Phule Pune University
Final Year of Information Technology (2019 Course)
(With effect from Academic Year 2022-23)

Semester VII

Course Code	Course Name	Teaching Scheme(Hours/week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	Mid-Sem	End-Sem	Termwork	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
414441	Information and Storage Retrieval	03	-	-	30	70	-	-	-	100	3	-	-	3
414442	Software Project Management	03	-	-	30	70	-	-	-	100	3	-	-	3
414443	Deep Learning	03	-	-	30	70	-	-	-	100	3	-	-	3
414444	Elective III	03	-	-	30	70	-	-	-	100	3	-	-	3
414445	Elective IV	03	-	-	30	70	-	-	-	100	3	-	-	3
414446	Lab Practice III	-	04	-	-	-	25	-	25	50	-	2	-	2
414447	Lab Practice IV	-	02	-	-	-	25	25	-	50	-	1	-	1
414448	Project Stage-I	-	-	02	-	-	50	-	-	50	-	-	2	2
414449	Audit Course7													
										Total Credit	15	03	02	20
	Total	15	06	02	150	350	100	25	25	650	15	03	02	20

Elective III:

- Mobile Computing
- High Performance Computing
- Multimedia Technology
- Smart Computing

Elective IV:

- Bioinformatics
- Introduction to DevOps
- Computer Vision
- Wireless Communications

Lab Practice-III:

It is based on subjects:

- Information and Storage Retrieval

Lab Practice-IV:

It is based on subjects:

- Deep Learning

Audit Courses 7:

- 414449A: Copyrights and Patents
- 414449B: Stress Management by Yoga
- 414449C: English for Research Paper Writing

Savitribai Phule Pune University
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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	Teamwork	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
414450	Distributed Systems	03	-	-	30	70	-	-	-	100	03			03
414451	Elective V	03	-	-	30	70	-	-	-	100	03			03
414452	Elective VI	03	-	-	30	70	-	-	-	100	03			03
414453	Startup and Entrepreneurship	-	-	03	-	-	50	-	-	50	-	-	03	03
414454	Lab Practice V	-	04	-	-	-	50	25	-	75		02		02
414455	Lab Practice VI	-	02	-	-	-	25	-	50	75		01		01
414456	Project Stage II	-	10	-	-	-	100	-	50	150		05		05
414457	AuditCourse8													
										Total Credit	09	08	03	20
	Total	09	16	03	90	210	225	50	75	650	09	08	03	20

Elective V:

- Software Defined Networks
- Social Computing
- Natural Language Processing
- Soft Computing
- Game Engineering

Elective VI:

- Ethical Hacking and Security
- Augmented and Virtual Reality
- Business Analytics and Intelligence
- Blockchain Technology

Lab Practice V:

It is based on subjects:

- Distributed Systems

Lab Practice VI:

It is based on subjects:

- Elective VI

Audit Courses 8:

- 414457A: Functional Programming in Haskell
- 414457B: Cyber Laws and Use of Social Media
- 414457C: Constitution of India

Savitribai Phule Pune University, Pune Bachelor of Information Technology	
Program Educational Objectives	
PEO1	**Possess strong fundamental concepts in mathematics, science, engineering and Technology to address technological challenges.**
PEO2	**Possess knowledge and skills in the field of Computer Science and Information Technology for analyzing, designing and implementing complex engineering problems of any domain with innovative approaches.**
PEO3	**Possess an attitude and aptitude for research, entrepreneurship and higherstudies in the field of Computer Science and Information Technology.**
PEO4	**Have commitment ethical practices, societal contributions through communities and life-long learning.**
PEO5	**Possess better communication, presentation, time management and team work skills leading to responsible & competent professional sand will be able to address challenges in the field of IT at global level.**

Program Outcomes		
Students are expected to know and be able to–		
PO1	Engineering knowledge	An ability to apply knowledge of mathematics, computing, science, engineering and technology.
PO2	Problem analysis	An ability to define a problem and provide a systematic solution with the help of conducting experiments, analyzing the problem and interpreting the data.
PO3	Design / Development of Solutions	An ability to design, implement, and evaluate software or a software /hardware system, component, or process to meet desired needs within realistic constraints.
PO4	Conduct Investigation of Complex Problems	An ability to identify, formulate, and provide essay schematic solutions to complex engineering /Technology problems.
PO5	Modern Tool Usage	An ability to use the techniques, skills, and modern engineering technology tools, standard processes necessary for practice as a IT professional.
PO6	The Engineer and Society	An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems with necessary constraints and assumptions.
PO7	Environment and Sustainability	An ability to analyze and provide solution for the local and global impact of information technology on individuals, organizations and society.
PO8	Ethics	An ability to understand professional, ethical, legal, security and social issues and responsibilities.
PO9	Individual and Team Work	An ability to function effectively as an individual or as a team member to accomplish a desired goal(s).
PO10	Communication Skills	An ability to engage in life-long learning and continuing professional development to cope up with fast changes in the technologies /tools with the help of electives, profession along animations and extra-curricular activities.
PO11	Project Management and Finance	An ability to communicate effectively in engineering community at large by means of effective presentations, report writing, paper publications, demonstrations.
PO12	Life-long Learning	An ability to understand engineering, management, financial aspects, performance, optimizations and time complexity necessary for professional practice.

Program Specific Outcomes(PSO)	
A graduate of the Information Technology Program will demonstrate -	
PSO1	An ability to apply the theoretical concepts and practical knowledge of Information Technology in analysis, design, development and management of information processing systems and applications in the interdisciplinary domain.
PSO2	An ability to analyze a problem, and identify and define the computing infrastructure and operations requirements appropriate to its solution. IT graduates should be able to work on large-scale computing systems.
PSO3	An understanding of professional, business and business processes, ethical, legal, security and social issues and responsibilities.
PSO4	Practice communication and decision-making skills through the use of appropriate technology and be ready for professional responsibilities.

SEMESTER – VII

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414441: Information Storage and Retrieval		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH): 03 hrs/week	**03 Credits**	**Mid_Semester: 30 Marks** **End_Semester: 70 Marks**

Prerequisite Courses,

1. Data Structures and Files.
2. Database management systems.

Companion Course, if any: Lab Practice III

Course Objectives:

1. To understand the concepts of information retrieval.
2. To understand the role of clustering in information retrieval.
3. To learn different indexing structures and searching techniques.
4. To evaluate the performance of the IR system and understand user interfaces for searching.
5. To understand information sharing on the web.
6. To understand the various applications of information retrieval giving emphasis to multimedia and distributed IR, web Search.

Course Outcomes:

On completion of the course, students will be able to

CO1. Understand the concept of Information retrieval and to apply clustering in information retrieval.
CO2. Use an indexing approach for retrieval of text and multimedia data.
CO3. Evaluate performance of information retrieval systems.
CO4. Apply the concepts of multimedia and distributed information retrieval.
CO5. Use appropriate tools in analyzing the web information
CO6. Simulate the working of a search engine and recommender system.

COURSE CONTENTS

Unit I	**Introduction to Information Retrieval**	**(06 hrs)**

Basic Concepts of IR, Data Retrieval & Information Retrieval, Text mining and IR relation, IR system block diagram, **Automatic Text Analysis:** Luhn's ideas, Conflation Algorithm, Indexing and Index Term Weighting, Probabilistic Indexing, Automatic Classification. Measures of Association, Different Matching Coefficients, Cluster Hypothesis, **Clustering Techniques: Rocchio's** Algorithm, Single pass algorithm, Single Link algorithm.

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

Unit II	**Indexing and Searching Techniques**	**(06 hrs)**

Indexing: Inverted file, Suffix trees & suffix arrays, Signature Files, Scatter storage or hash addressing.
Searching Techniques: Boolean Search, sequential search, Serial search, cluster-based retrieval, Query languages, Types of queries, Patterns matching, structural queries.
IR Models: Basic concepts, Boolean Model, Vector Model, Probabilistic Model.

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

Unit III	Evaluation and Visualization of Information Retrieval System	(06 hrs)
Performance evaluation: Precision and recall, MRR, F-Score, NDCG, user-oriented measures. **Visualization in Information System:** Starting points, Query Specification, document context, User relevance judgment, Interface support for search process.		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Distributed and Multimedia IR**	**(06 hrs)**
Distributed IR: Introduction, Collection Partitioning, Source Selection, Query Processing, **Multimedia IR:** Introduction, Data Modeling, Query Language, Background-Spatial Access Method, A Generic Multimedia Indexing Approach, One Dimensional Time Series, Two-Dimensionalcolor Images, Automatic Feature Extraction, Trends and Research Issue.		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Web Searching**	**(06 hrs)**
Introduction, Challenges, Web Characteristics, **Search Engines:** Centralized Architecture, Distributed Architecture, User Interfaces, Ranking, Crawling the web, Indices, Browsing, Meta-searchers, Searching using Hyperlinks, Trends and Research Issues, **Introduction to Web Scraping:** Python for web scraping, Request, HTML parsing, Beautiful Soup.		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Advanced Information Retrieval**	**(06hrs)**
XML Retrieval: Basic XML concepts, Challenges in XML retrieval, Vector space model for XML retrieval, Evaluation of XML retrieval, Text-Centric vs. Data-Centric XML retrieval. **Recommendation system:** Collaborative Filtering and Content Based Recommendation of Documents and Products. Introduction to Semantic Web.		
Mapping of Course Outcomes for Unit VI	**CO6**	

Textbooks:

1. Ricardo Baeza-Yates, Berthier Riberio–Neto, Modern Information Retrieval, Pearson Education, ISBN: 81-297-0274-6.
2. C.J. Rijsbergen, Information Retrieval, (www.dcs.gla.ac.uk), Second Edition ISBN:978-408709293.
3. Ryan Mitchell, Web Scraping with Python, O'reilly, second Edition, ISBN: 9781491985571.
4. Ricci F, Rokach L, Shapira B, Kantor P, Recommender Systems Handbook, Springer, ISBN:978-0-387-85819-7.
5. Norbert Fuhr, MouniaLalmas, Saadia Malik, Gabriella Kazai, Advances in XML Information Retrieval and Evaluation, Springer New York Publisher.

Reference Books:

1. ChabaneDjeraba, Multimedia mining: A highway to intelligent multimedia documents, Kulwer Academic Publisher, ISBN: 1-4020-7247-3.
2. V. S. Subrahamanian, Satish K. Tripathi, Multimedia information System, Kulwer Academic Publisher.
3. Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze, An Introduction to Information Retrieval, Cambridge University Press, 2008.
4. Marek Kowalkiewicz, Maria E. Orlowska, Tomasz Kaczmarek, Witold Abramowicz, Web Information Extraction and Integration, Springer New York Publisher.
5. David Grossman, Ophir Frieder, Information Retrieval - Algorithms and Heuristics, Springer International Edition, ISBN: 978-1-4020-3004-8.
6. Hang Li, Learning to Rank forInformation Retrieval and Natural Language. 7. Processing, Morgan
7. & Claypool, ISBN: 9781608457076.
8. Robert Korfhage, Information Storage and Retrieval, John Wiley & Sons, First Edition,ISBN: 9788126507702.
9. Zhang, Jin, Visualization for Information Retrieval, Springer-Verlag Berlin Heidelberg,1st Edition, ISBN: 978-3-642-09442-2.

E Books / E Learning References:

1. https://web.stanford.edu/class/cs276/handouts/EvaluationNew-handout-1-per.pdf.
2. https://www.coursera.org/learn/text-retrieval

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414442: Software Project Management		
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		

Course Objectives:

1. To discuss the fundamentals of Software Project Management
2. To explain Project Design and Project Evaluation.
3. To acquire skill in Activity Planning and to deal with Risk Management
4. To provide platform to understand through different tools about Project Tracking, Monitoring & Control.
5. To discuss Staff Selection Process and the issues related to Staff Management.
6. To provide exposure to modern tools used for Software Project Management.

Course Outcomes:

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

CO1. Apply the practices and methods for successful Software Project Management
CO2. Create Design and Evaluate Project
CO3. Analyze Project Schedule and calculate Risk Management with help of tools.
CO4. Demonstrate different tools used for Project Tracking, Monitoring & Control.
CO5. Identify Staff Selection Process and the issues related to Staff Management.
CO6. Discuss and use modern tools for Software Project Management.

COURSE CONTENTS

Unit I	**Introduction to Software Project Management**	**(6hrs.)**

Introduction to Software Project Management: Why is Software Project Management important? What is a Project? Contract Management, Activities Covered by Software Project Management, Plans, Methods and Methodologies, Some Ways of Categorizing Software Projects, Stakeholders, Setting Objectives, Business Case, Project Success, and Failure, what is Management? Management Control, Traditional versus Modern Project Management Practices.

Case study: Online Shopping System.

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

Unit II	**Project Design and Evaluation**	**(6 hrs.)**

Project Design: Overview of UML diagrams: Use case, Class, Activity, State, Sequence, Deployment

Project Evaluation: What is Project Evaluation? Importance of Project Evaluation, Cost Benefit Evaluation Techniques

Process Evaluation and Improvement: The Process Improvement Process: The Process Improvement Cycle, Process Measurement: The GQM Paradigm, Process Analysis: Techniques of Process Analysis, Process change: The Process Change Process

Case study: Online Shopping System, Perform Cost-Benefit Analysis using Microsoft Excel

Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Activity Planning & Risk Management**	**(6 hrs.)**
Objectives of Activity planning – Project schedules – Activities – Sequencing and Scheduling, Network Planning Models – Formulating Network Model – Forward Pass & Backward Pass Techniques. Risk Management- Introduction, Risk Management, Risk Assessment, Risk identification, Risk Prioritization, Risk Planning, Risk control, Risk Strategies, Evaluating Risk to the schedule Study Risk Management Tools - SpiraPlan by Inflectra, Risk Management Studio, GRC Cloud **Case study:** Online Shopping System		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Project Tracking, Monitoring & Control**	**(6hrs.)**
Introduction: Project Tracking and Control, Monitoring and Control Processes, Collection of Project data, Partial Completion Reporting. **Data Collection Methods:** Phone vs. Online vs. In-Person Interviews, Visualizing Progress, Visual Project Management, Kanban Boards, Project Calendars, Cost Monitoring, Four Steps in Project Cost Management, Earned Value Analysis, Project Tracking, Effective Approach to Track Projects, Status Report: Four features of a Good Status Report, Change Control, Different factors of Change Control Process, Change Process Flow-Diagram, Software Configuration Management, Tasks in SCM Process, Participant of SCM Process. **Software Configuration Management Tools:** Git, Team Foundation Server, Ansible, Managing Contracts, The Stages of Contract Management, Challenges of Contract Management, Benefits of Contract Management, Types of Contracts in Software Project Management **Case study:** Online Shopping System, track different versions of a software using Git tool		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Managing People and Organizing Teams**	**(6 hrs.)**
Understanding Behavior-Organizational Behavior- Selecting the Right Person for the Job-Instruction in the Best Methods-Motivation-The Oldham-Hackman Job Characteristics Model- Stress-Health and Safety- Ethical and Professional Concerns-Becoming a team-Decision Making-Organization and Team Structures-Coordination Dependencies-Dispersed and Virtual Teams-Communication Genres and plans-Leadership. **Case study:** Team Buildingin Project Management with reference to academic project work.		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Applications of Software Project Management in Industry**	**(6 hrs.)**

Agile Project Management with Azure DevOps: An Overview of Application Lifecycle Management & Azure DevOps, Traceability, Visibility, Collaboration, and Extensibility. Difference between Microsoft TFS and Azure DevOps.

Metrics in Agile Practice: Introduction to Metrics inAgile Practice, Metrics for Project Management, Agile Project Management in Azure DevOps and TFS.

Case study: Online Shopping System.

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

Textbooks:

1. Bob Hughes, Mike Cotterell and Rajib Mall: Software Project Management – FifthEdition, Tata McGraw Hill, New Delhi. - ***(for Unit 1, 3, 5)***
2. A Guide to the Project Management Book of Knowledge-Seventh Edition. ***(For Unit 4)***
3. Walker Royce, "Software Project Management" a unified approach. Addison Wesley ISBN 0-20130958-0. ***(For Unit 6)***

Reference Books:

1. JackMarchewka," Information Technology-Project Management", Wiley Student Version, 4th Edition, 2013.
2. Lan Somerville, Software Engineering, Fifth Edition, Addison Wesley Publications, 1996. *(For Unit 2)*
3. JIM Arlow, Ila Neustadt, UML 2 and the Unified Process, Pearson, Second Edition, ISBN:9788131700549 Tom Pender, UML 2 Bible, Wiley India, ISBN: 9788126504527. *(For Unit 2)*
4. James P Lewis, "Project Planning, Scheduling & Control", McGraw Hill, 5th Edition, 2011.
5. PankajJalote," Software Project Management in Practice", Pearson Education, 2002.
6. Gopalaswamy Ramesh, "Managing Global Software Projects" – McGraw Hill Education (India), Fourteenth Reprint 2013.
7. Joachim Rossberg "Agile Project Management with Azure DevOps" Apress. *(For Unit 6)*
8. Robert K. Wyzocki, Rudd McGary, Effective Project Management, WILEYDreamtech India Pvt. Ltd., 2000.

Books / E Learning References:

1. https://www.inflectra.com/SpiraPlan/(for Unit 3)
2. https://www.techtarget.com/searchsecurity/definition/governance-risk-management-and-compliance-GRC(for Unit 3)
3. https://www.softwaretestinghelp.com/risk-management-tools/#3_Risk_Management_Studio (For Unit 3)
4. NPTEL: https://nptel.ac.in/courses/106101061/29
5. https://onlinecourses.nptel.ac.in/noc17_mg01/preview
6. Coursera: https://www.coursera.org/learn/uva-darden-project-management
7. http://managementhelp.org/evaluation/program-evaluation-guide.htm.
8. https://nptel.ac.in/courses/106105218 (NPTEL)
9. Virtual Labs:- Software Engineering- **1) http://vlabs.iitkgp.ernet.in/se/3/** **2) http://vlabs.iitkgp.ernet.in/se/5/** **3) http://vlabs.iitkgp.ernet.in/se/6/** **4) http://vlabs.iitkgp.ernet.in/se/7/**

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414443: Deep Learning		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH): 3 hrs/week	**03 Credits**	**Mid_Semester : 30 Marks** **End_Semester : 70 Marks**

Prerequisite Courses:1. Machine Learning 2. Mathematics

Companion Course: Artificial Intelligence Soft computing

Course Objectives:

1. To introduce the theoretical foundations, algorithms, methodologies, and application of neural networks and deep learning.
2. To design and develop an application-specific deep learning model.
3. To provide the practical knowledge handling and analyzing real world applications.

Course Outcomes:

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

CO1. Understand the theoretical foundations, algorithms, and methodologies of Deep Learning.
CO2. Apply the concepts of Convolution Neural Networks and use of popular CNN architectures.
CO3. Compare Feed Forward Neural Network and Recurrent Neural Network and learn modeling the time dimension using RNN and LSTM.
CO4. Elaborate unsupervised deep learning algorithms like Autoencoders.
CO5. Explore Representation Learning and Transfer Learning techniques using variants of CNN architecture.
CO6. Evaluate the performance of deep learning algorithms and to provide solution for various real-world applications.

COURSE CONTENTS

Unit I	**Fundamentals of Deep Learning**	**(06 hrs)**
What is Deep Learning?, Multilayer Perceptron ,Feed forward neural, Back propagation, Gradient descent, Vanishing gradient problem, **Activation Functions:** RELU, LRELU, ERELU, Optimization Algorithms, **Hyper parameters:** Layer size, Magnitude (momentum, learning rate),Regularization (dropout, drop connect, L1, L2)		
Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**Convolutional Neural Network:**	**(06 hrs)**
Introduction to CNN, Convolution Operation, Parameter Sharing, Equivariant Representation, Pooling, Variants of the Basic Convolution Function, The basic Architecture of CNN, Popular CNN Architecture – AlexNet.		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Recurrent Neural Networks**	**(06 hrs)**

Recurrent Neural Networks: Types of Recurrent Neural Networks, Feed-Forward Neural Networks vs Recurrent Neural Networks, Long Short-Term Memory Networks (LSTM), Encoder Decoder architectures, Recursive Neural Networks		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Autoencoders**	**(06 hrs)**
Undercomplete Autoencoders, Regulraized Autoencoders-Sparse Autoencoders, Stochastic Encoders and Decoders, Denoising Autoencoders, Contractive Autoencoders, Applications of Autoencoders.		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Representation Learning**	**(06 hrs)**
Greedy Layerwise Pre-training, Transfer Learning and Domain Adaption, Distributed Representation, Variants of CNN: DenseNet.		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Applications of Deep Learning**	**(06 hrs)**
Overview of Deep Learning Applications: Image Classification, Social N/w/ analysis, Speech Recognition, Recommender system, Natural Language Processing.		
Mapping of Course Outcomes for Unit VI	**CO6**	

Textbooks:

1. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
2. Ian Goodfellow, YoshuaBengio and Aaron Courville, “Deep Learning”, MIT Press, 2017.
3. Nikhil Buduma, "Fundamentals of Deep Learning Designing Next-Generation Machine Intelligence Algorithms" O'Reilly

Reference Books:

1. Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding.
2. Deep Neural Networks” Apress, 2018.
3. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
4. Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.
5. Antonio Gulli, Sujit Pal "Deep Learning with Keras", Packt Publishers, 2017.
6. Francois Chollet "Deep Learning with Python", Manning Publications, 2017.

E Books / E Learning References :

1. Michael Nielsen, “Neural Networks and Deep Learning”, Online book, 2016 (http://neuralnetworksanddeeplearning.com/)
2. Deep Learning for Visual Computing https://onlinecourses.nptel.ac.in/noc22_ee54
3. Deep Learning - IIT Kharagpur https://onlinecourses.nptel.ac.in/noc22_cs22
4. Deep Learning - IIT Ropar https://onlinecourses.nptel.ac.in/noc22_cs35/
5. Introduction to Deep Learning : https://www.coursera.org/learn/introduction-to-deep-learning-boulder
6. Deep Learning Specialization : https://www.coursera.org/specializations/deep-learning

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414444: Elective – III (Mobile Computing)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH):3 hrs/week	**03 Credits**	**Mid_Semester: 30 Marks** **End_Semester: 70 Marks**

Prerequisite Courses :

Companion Course:

Course Objectives:

1. To understand the basic concepts of mobile computing.
2. To learn the basics of mobile telecommunication system.
3. To understand the Generations of Mobile Communication Technologies.
4. To be familiar with the network layer protocols and Ad-Hoc networks.
5. To know the basis of transport and application layer protocols.
6. To gain knowledge about different mobile platforms and application development.

Course Outcomes:

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

CO1. understand the basic concepts of mobile computing, MAC and different multiplexing technics.
CO2. understand Protocols, Connection Establishment, Frequency Allocation, Routing of mobile telecommunication system like GSM, GPRS, UMTS.
CO3. understand the Generations of Mobile Communication Technologies
CO4. learn mobile IP , Adhoc – Network, Reactive Routing protocols, Multicast Routing.
CO5. obtaining knowledge of transport layer protocol TCP, File System, and different application layer protocols.
CO6. gain knowledge about different mobile platforms**,** operating Systems, Software Development Kit, Security Issues.

COURSE CONTENTS

Unit I	**Introduction**	**(06 hrs)**

Introduction to Mobile Computing: Applications of Mobile Computing, A short history of wireless communication,

Medium Access Control: Motivation for a specialized MAC: Hidden and Exposed terminals. Near and Far terminals.

SDMA, FDMA, TDMA: Fixed TDM, Classical Aloha, Slotted Aloha, Carrier sense multiple access, Demand assigned multiple access, PRMA packet reservation multiple access, Reservation TDMA, Multiple access with collision avoidance, Polling, Inhibit sense multiple access.

CDMA: Spread Aloha multiple access.

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

Unit II	Mobile Telecommunication System	(06 hrs)
Introduction to Cellular Systems, **GSM:** Services &Architecture, Protocols, Connection Establishment, Frequency Allocation, Routing, Mobility Management, Security, **GPRS, UMTS:** Architecture, Handover, Security.		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Generations of Mobile Communication Technologies.**	**(06 hrs)**
First Generation Wireless Networks, Second Generation (2G) Wireless Cellular Networks, Major 2G standards, 2.5G Wireless Networks, Third Generation 3G Wireless Networks, Fourth Generation 4G wireless networks, Fifth Generation 5G wireless networks		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Mobile Network Layer**	**(06 hrs)**
Mobile IP: Goals, assumptions and requirements, Entities and Terminology, IP packet delivery, Agent advertisement and discovery, Registration, Tunnelling and Encapsulation, Optimizations, Reverse tunnelling, **IPv6:**DHCP, **AdHoc networks:** Routing, Proactive protocol-DSDV, **Reactive Routing Protocols:** DSR, AODV, Hybrid routing –ZRP, **Multicast Routing:** ODMRP, Vehicular Ad Hoc networks (VANET) MANET Vs VANET Security.		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Mobile Transport Layer**	**(06 hrs)**
Traditional TCP: Congestion control, Slow start, Fast retransmit/fast recovery, Implications on mobility; Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission/time-out freezing, Selective retransmission, Transaction oriented TCP. **Support for Mobility:** File systems: Consistency, Examples. **World Wide Web:** Hypertext transfer protocol, Hypertext markup language, some approaches that might help wireless access, System architectures **Wireless application protocol:** Architecture, Wireless datagram protocol, Wireless transport layer security, Wireless transaction protocol, Wireless session protocol, Wireless application environment, Wireless markup language, WML script, Wireless telephony application, Examples Stacks with WAP, Mobile databases, Mobile agents.		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Mobile Platforms and Applications**	**(06 hrs)**
Mobile Device Operating Systems, Special Constrains & Requirements, Commercial Mobile Operating Systems. **Software Development Kit:** Ios, Android, Blackberry, Windows Phone, M Commerce, Structure, Pros &Cons, Mobile Payment System, Security Issues.		

Mapping of Course Outcomes for Unit VI	CO6

Textbooks:

1. Yi Bang lin : "Wireless and mobile Network Architectures" Wiley publications
2. William c.y. Lee: "Mobile Communications and Design Fundamentals" Wiley publications

Reference Books:

1. Jochen Schiller, —Mobile Communications, PHI, Second Edition, 2003.
2. Prasant Kumar Pattnaik, Rajib Mall, —Fundamentals of Mobile Computing‖, PHI Learning Pvt.Ltd, New Delhi – 2012
3. C.K.Toh, —AdHoc Mobile Wireless Networks‖, First Edition, Pearson Education, 2002.
4. Principles of Mobile Computing, 2nd Edition, Uwe Hansmann, LotharMerk, Martin Nicklous, Thomas Stober, Springer
5. Mobile Computing, Tomasz Imielinski, Springer

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414444: Elective – III (High Performance Computing)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH): 3 hrs/week	**03 Credits**	**Mid_Semester: 30 Marks** **End_Semester : 70 Marks**

Prerequisite Courses, if any:
Computer Organization, Processor Architecture, Operating Systems

Companion Course, if any:

Course Objectives:

1. To study parallel computing and Parallel Programming Platforms
2. To be conversant with performance of parallel algorithm design
3. To understand the Basic Communication Operations
4. To analyze parallel programming using analytical modeling
5. To understand CUDA architecture
6. To know parallel algorithms for high performance computing

Course Outcomes:

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

CO1. Understand concepts of parallel computing, its application areas and parallel computing platforms
CO2. Apply different Parallel programming paradigm and Decomposition Techniques.
CO3. Correlate various communication calls.
CO4. Analyze and Measure different Performance Metrics.
CO5. Perform CUDA Programming.
CO6. Build the logic to develop parallel algorithms for high performance computing.

COURSE CONTENTS

Unit I	Introduction to Parallel Computing	(6 hrs)

Introduction: What is parallel computing? Motivating Parallelism, Scope of Parallel Computing, Parallel Computing - Grand Challenges and Advantages, Dichotomy of Parallel Computing Platforms (Flynn's Classifications, Distributed Memory Architecture, Shared Memory Architecture, Hybrid Architecture), Communication Costs in Parallel Machines, Interconnection Networks and Routing Mechanisms. Impact of Process-Processor Mapping and Mapping Techniques.

Mapping of Course Outcomes for Unit I	CO1

Unit II	Principles of Parallel Algorithm Design	(6 hrs)

Parallel programming paradigm (Task forming, Pipelining, divide and conquer), Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Parallel Algorithm Models, Accelerator based computing (Introduction to CUDA and OpenACC)

Mapping of Course Outcomes for Unit II	CO2

Unit III	Basic Communication	(6 hrs)

Message passing paradigm: Synchronous and asynchronous communication calls. Blocking Vs Nonblocking, Introduction to MPI: Point to point communication, Collecting Communication: One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Shared memory programming and synchronisation.		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Analytical Modeling of Parallel Programs**	**(6 hrs)**
Sequential execution time, parallel execution time and Sources of Overhead in Parallel Programs , Performance Metrics for Parallel Systems(Speedup, efficiency, Amdahl's law, Gustafson's law) , The effect of Granularity on performance , Scalability of parallel systems , Minimum execution time and minimum cost-optimal execution time, Asymptotic Analysis of parallel programs , other scalability metrics.		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Shared Memory Programming**	**(6 hrs)**
CUDA Architecture, CUDA Programming (Kernels, synchronization, Memory Contention and Device to Host Communications), OpenMP Programming		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Parallel Algorithms and Applications**	**(6 hrs)**
Dense Matrix Algorithms (Canon's Algorithm): Matrix-Vector Multiplication, Matrix-Matrix Multiplication, Monto Carlo Simulation (Calculation of PI), Parallel Sorting Algorithms(Bubble Sort and its Variants, Parallelizing Quick sort) Parallel graph (All-Pairs Shortest Paths, Algorithm for sparse graph) Parallel search algorithms (Depth-First Search, Best-First Search)		
Mapping of Course Outcomes for Unit VI	**CO6**	

Textbooks:

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. Jason sanders, Edward Kandrot, "CUDA by Example", Addison-Wesley, ISBN-13: 978-0- 13-138768-3

Reference Books:

1. Kai Hwang," Scalable Parallel Computing", McGraw Hill 1998, ISBN:0070317984
2. Shane Cook, "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs", Morgan Kaufmann Publishers Inc. San Francisco, CA, USA 2013 ISBN: 9780124159884
3. David Culler Jaswinder Pal Singh," Parallel Computer Architecture: A Hardware/Software Approach", Morgan Kaufmann,1999, ISBN 978-1-55860-343-1

E Books / E Learning References:
https://www.geeksforgeeks.org/introduction-to-cuda-programming/
http://cuda.ce.rit.edu/tutorials/tutorials.htm

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414444: Elective – III (Multimedia Technology)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH): 3hrs/week	**03 Credits**	**Mid_Semester: 30 Marks** **End_Semester : 70Marks**

Prerequisite Courses:

1.Data Structures and Files

2. Computer Graphics

Companion Course, if any: Not Applicable

Course Objectives:

1. To describe basic components of multimedia (text, image, audio, video, and animation).
2. To state text and image file formats and apply different compression techniques.
3. To classify different audio and video file formats.
4. To define animation techniques and use open-source authoring tools.
5. To express virtual reality and VR devices used in various applications.
6. To identify emerging trends and practice various tools.

Course Outcomes:

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

CO1. Understand basic building block and applications of Multimedia.

CO2. Solve and analyze different algorithms for text and image compression.

CO3. Classify different audio and video file formats of Multimedia.

CO4. Apply open-source authoring tools of animation.

CO5. List various devices used in virtual reality and its use in daily life.

CO6. Recognize emerging trends in Multimedia.

COURSE CONTENTS

Unit I	**Introduction to Multimedia**	**(6hrs)**

Goals, objectives, and characteristics of multimedia, what is Multimedia, Multimedia and Hypermedia, **Multimedia building blocks:** text, image, audio, video, animation, Overview of Multimedia Software Tools, Multimedia Applications, Multimedia architecture, Evolving Technologies for Multimedia Systems, Some useful editing, and Authoring tools

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

Unit II	**Text and Image Processing**	**(6hrs)**

Text: Text file formats: TXT, DOC; RTF, PDF, PS, EPS, OXPS **Text compression:** Huffman coding, LZ & LZW **Image:** Image Data Representation, Image File formats - BMP, TIFF, JPEG, GIF, PNG **Image processing:** Acquisition, Storage, Communication, Display, Enhancement **Types of Compression:** Lossless: RLE, Shannon - Fano algorithm, Arithmetic coding. **Lossy:** Vector quantization, Fractal Compression Technique, Transform coding and Hybrid: JPEG-DCT		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Audio and Video Processing**	**(6 hrs)**
Audio: Nature of sound waves, characteristics of sound waves, Use of audio in computer applications, psycho-acoustic, MIDI, Digital audio file formats: AIFF, VOC, AVI, WMA, OGG, PCM,MP3,AAC Audio compression techniques: DM, ADPCM and MPEG. **Video:** video signals formats, Video transmission standards: EDTV, CCIR, CIF, SIF, HDTV, Video file formats: AVI, MOV,RM,WAV,FLV,3GP,Video editing, Video Compression: H-261,H-263, MPEG		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Animation**	**(6hrs)**
Animation: Historical Background, Uses of Animation, Traditional Animation, Principal of Animation, Techniques of animation, Computer based Animation, Animation on the Web,3D Animation, Rendering Algorithms, Animation File formats, Animation **tools:** Autodesk Maya		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Virtual Reality**	**(6hrs)**
Architecture of VR, Concept and History of VR, Human Physiology and Perception, Forms of VR, VR applications, **VR devices:** Hand Gloves, Head mounted tracking system, VR chair, CCD, VCR, 3D Sound System, Head mounted display, Touchable Holograms, **Case Study:** Virtual Reality in education and health care		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Trends in Multimedia**	**(6hrs)**
Multimedia networking, Quality of data transmission, Multimedia over IP, Media on Demand, Multimedia in Android: Android Multimedia Framework Architecture, Multimedia Databases: storage, retrieval, organization, Multimedia application development: software life cycle overview, Features of Multimedia (text, Image, audio and video) processing software, **Gaming:** Facial Recognition, Voice Recognition,GestureControl,High-DefDisplays,Augmented Reality, Mobile Gaming, Cloud Gaming On-Demand Gaming. **VFX:** Visual Effect and Special Effect, why use Visual Effect, Blender VFX software.		
Mapping of Course Outcomes for Unit VI	**CO6**	

Textbooks:

1. Ralf Steinmetz and Klara Nahrstedt "Multimedia Computing, Communication and Applications ",Pearson Education.
2. Ranjan Parekh,"Principlesof Multimedia",2/E, TataMcGraw-Hill,ISBN:1259006506
3. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016

Reference Books:

1. Ze-Nian Li, Marks S. Drew, "Fundamentals of Multimedia", Pearson Education.
2. Prabhat K. Andleigh, KiranThakrar, “Multimedia Systems Design”, Pearson Education Unit I
3. Gerard Jounghyun Kim, “Designing Virtual Systems: The Structured Approach”, 2005.
4. Foley, Dam, Feiner, Hughes," Computer Graphics Principles & Practice", 2nd Ed, Pearson Education
5. Gonzalez,Woods,"DigitalImageProcessing" Addison Wesley.
6. AlanH.Watt and Mark Watt,"Advanced Animation and Rendering Techniques :Theory and Practice",Addison-Wesley, ACMPress, ISBN:0201544121.
7. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig,Morgan Kaufmann Publishers, San Francisco, CA, 2002.
8. J.R.Parker,“IntroductiontoGameDevelopmentUsingProcessing”,Mercury Learning & Information ;Pap/Comedition.
9. Jeffrey A. Okun& Susan Zwerman, The VES Handbook of Visual Effects: Industry Standard VFX Practices and Procedures, Publisher: Focal Press 2010.

E Books / E Learning References:

1. http://lavalle.pl/vr/book.html
2. https://nptel.ac.in/courses/106/106/106106138
3. https://www.coursera.org/learn/introduction-virtual-reality
4. https://wethegeek.com/technology-trends-in-future-gaming-industry
5. https://docs.blender.org/manual/en/latest/grease_pencil/visual_effects/index.html

SavitribaiPhule Pune University, Pune
Final Year Information Technology (2019 Course)
414444: Elective – III (Smart Computing)

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

Prerequisite Courses, if any:

1. Human Computer Interaction.
2. Basics of Computer Network
3. Processor architecture and interfacing
4. Computer Network and Security

Companion Course, if any:

Course Objectives:

1. To describe smart computing, its properties applications and architectural design.
2. To explain various smart devices and services used in ubiquitous computing.
3. To be acquainted with interfacing of sensors and actuators with microprocessor.
4. To understand Internet of Things and its usefulness for society.

Course Outcomes:

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

CO1. Demonstrate the knowledge of design of smart computing and its applications.
CO2. Describe different generations of mobile and mobile computing projects
CO3. Demonstrate the knowledge of design of Ubicomp and its applications.
CO4. Explain smart devices and services used Ubicomp.
CO5. Implement interfacing of various sensors, actuators to the development boards
CO6. Compare various IoT communication technologies and smart computing applications.

COURSE CONTENTS

Unit I	Introduction to Smart Computing	(06 hrs)

What is smart Computing? Bartel's definition of smart computing, The Five A's Of Smart Computing, Examples of smart computing, smartphone and mobile computing, Introduction to smartphones, tablet, PDA, or other digital mobile devices, Introduction to smartphone system architecture, Convergence of sensing Computing and Communication, Pervasive Computing or ubiquitous computing, Emerging Mobile Technologies and Applications.

Mapping of Course Outcomes for Unit I	CO1

Unit II	Mobile Computing	(06hrs)

Evolution of Cellular Networks and Cell Phones (1G,2G,3G,4G and 5G),Vision of mobile computing, Convergence of Mobile Access, Pervasiveness of Mobile Intelligence, Mobile Computing Challenges, study of notable mobile computing projects (oxygen, smart dust, AURA, Wireless GRID)

Mapping of Course Outcomes for Unit II	CO2

Unit III	Ubiquitous Computing	(06 hrs)

Concept of Ubiquitous Computing and Advantages, Ubiquitous Computing Applications and Scope, Properties of Ubiquitous Computing, Modelling the Key Ubiquitous Computing Properties. Ubiquitous System Environment Interaction. Architectural Design for **UbiCom-Systems:** Smart DEI Model.		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Smart Devices and Services**	**(06 hrs)**
Smart Devices and Service properties, Smart mobile devices and Users, Mobile code, Smart Card Devices and Networks, Service Architecture Models. Service Provision Lifecycle. Virtual Machines and Operating Systems, OS for Mobile Computers and Communicator Devices.		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Sensors, Actuators and interfacing**	**(06 hrs)**
Sensors: Roles of Sensors & Actuators, Types of sensors, Working of Sensors: Position, occupancy and motion, velocity and acceleration, force, pressure, flow, Acoustic, Humidity, light camera etc. **Development boards:** Types of boards - Arduino, Raspberry pi, Beagle bone, ESP8266, Interfacing of sensors with development boards. Micro- Electro-Mechanical Systems (MEMS), Embedded Systems and Real-Time Systems. Programmable and PID type control system, Robots.		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Applications of Smart Computing**	**(06 hrs)**
Introduction of IoT: Definition and characteristics of IoT, Technical Building blocks of IoT, Device, Communication Technologies, Data, Physical design of IoT, IoT enabling technologies. **Case studies:** **Smart Home:** Characteristics of Smart Home - Smart Home Energy Management, Smart Appliances, Communication Technologies for Smart Homes, maintenance, security, challenges. **Smart Agricultural:** characteristics and applications -Scarecrow, Smart Irrigation System, Crop Water Management, Integrated Pest Management, Sensor-based field and resource mapping, Remote equipment monitoring)		
Mapping of Course Outcomes for Unit VI	**CO6**	
Textbooks:		
1. Smart Phone and Next Generation Mobile Computing (Morgan Kaufmann Series in Networking), PeiZheng, Lionel Ni **2.** Stefan Poslad, Ubiquitous Computing, Wiley, Student Edition, ISBN:9788126527335John Krumm, Ubiquitous Computing Fundamentals **3.** ArshdeepBahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515.		

Reference Books:
1. Principles Of Mobile Computing, Hansmann, LotharMerk, Martin Niclous, Stober **2.** Mobile Computing, Tomasz Imielinski, Springer **3.** Laurence T. Yeng, EviSyukur and Seng W. Loke, Handbook on Mobile and UbiquitousComputing, CRC, 2nd Edition, ISBN: 9781439848111 **4.** Lyla B. Das, "Embedded Systems: An Integrated Approach" Pearson, ISBN: 9332511675, 9789332511675 **5.** Smart Internet of things projects AgusKurniawanPackt - Sep 2016 978-1- 78646- 651-8 2 The Internet of Things Key Olivier Willy Publication 2nd Edition 978-
E Books / E Learning References
1. White Paper on Smart Computing Drives the New Era Of IT Growth by Andrew H. Bartels for Vendor Strategy Professionals.

Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
414445: Elective – IV (Bioinformatics)

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

Prerequisite Courses:
Basics of biology, Design and Analysis of Algorithms Basic concepts of Data Mining and Machine Learning

Companion Course: biotechnology, drug designing and development, bio-analytics, proteomics

Course Objectives:

1. To introduce basic concepts and functions of bioinformatics and its applications
2. To study and Understand concept of biological databases, to study different Pattern Matching Techniques and algorithms for knowledge discovery in Bioinformatics databases through sequence alignment algorithms.
3. To analyze various simulation tools and algorithms in Bioinformatics for fast pairwise sequence alignment
4. To study Protein Structure Modeling and simulation and Drug discovery process and Anatomy of Proteins
5. To study Recent Trends in Bioinformatics such as Environmental Biotechnology, Application of nanotechnology, Genetic engineering etc.

Course Outcomes:

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

CO1. Integrate biological concepts with information technologies to study the biological system.
CO2. Study Gene structure, various biological database, and methods to manage the different types of biological data.
CO3. Describe principles and algorithms of pairwise and multiple alignments.
CO4. Study various bioinformatics tools and Algorithm.
CO5. Understand modeling and simulation in bioinformatics, drug discovery process. and Protein Structure.
CO6. To Gain awareness in field of System Biology and Human Disease.

COURSE CONTENTS

Unit I	Basic of Bioinformatics	(06 hrs)

What is Bioinformatics and its relationship with molecular biology, Information Theory and Central Dogma of Molecular Biology, Bioinformatics Scope, Challenges and Bioinformatics Applications, Features and Major Databases in Bioinformatics, Interdisciplinary nature of Bioinformatics, Major Bioinformatics databases and tools.

Mapping of Course Outcomes for Unit I	CO1

Unit II	Biological database and Gene Structure	(06hrs)

Types of biological Database, Primary, Secondary and Structural data bases, tools for web search, data retrieval tools **Protein primary databases** - PIR, SWISS-PROT; Composite protein sequence database -NRDB, OWL, **Protein secondary databases** - PROSITE, Profiles; Database on protein structures – PDB, Genome databases - human (HGP) **What is a Gene?** Structural Genes, Genome Sequencing and Applications of Genetics Maps		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Sequence Alignment and Data Visualization**	**(06 hrs)**
Introduction to Sequence alignments and dynamic programming; Local alignment and Global Alignment. Methods of Sequence Alignments, Scoring Matrix: PAM and BLOSUM Sequence Visualization, Sequence maps, Structure Visualization and rendering tools, Statistical Concepts Microarray.		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Bioinformatics Algorithm and Tools**	**(06 hrs)**
Biological algorithm vs. computer algorithms, Clustering, and classification algorithms FASTA Algorithm, BLAST Algorithm and its comparison, Hidden Markov Models, Graph and Genetics Algorithm.		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Drug Discovery and Protein structure determination techniques**	**(06hrs)**
What is Drug and Drug discovery process? Modelling and Simulation Process, Applications of Bioinformatics in Drug Discovery Process. **Proteins:** Principles of protein structure; anatomy of proteins – Hierarchical organization of protein **structure –** Primary. Secondary, Super secondary, Tertiary and Quaternary structure.		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Recent Trends in Bioinformatics**	**(6hrs)**
Environmental Biotechnology, Application of nanotechnology, Genetic engineering, and therapeutic application of stem cell. Future of medicine		
Mapping of Course Outcomes for Unit VI	**CO6**	

Textbooks:
1. S.C.Rastogi, N.Mendiratta, P.Rastogi 'Bioinformatics-Methods & Application Genomics, Proteomics and Drug Discovery', Third Edition, Prentice Hall of India. **2.** Bryan Bergeron, 'Bioinformatics Computing', Pearson Education **3.** OrpitaBosumSimminder Kaur Thukral 'Bioinformatics: Databases, Tools and Algorithms', Oxford press. **4.** Neil C. Jones and Pavel A. Pevzner, "An Introduction to Bioinformatics Algorithms", MIT Press, First IndianReprint 2005
Reference Books:
1. SupratimChoudhuri , "BIOINFORMATICS FOR BEGINNERS Genes, Genomes, Molecular Evolution, Databases and Analytical Tools", Academic Press is an imprint of Elsevier **2.** Baxevanis, A. D. and Ouellette. B. F. F. 2004. Bioinformatics: A practical guide to theanalysis of genes and proteins. Wiley Inter-science. New York. 560 p.
E Books / E Learning References:
1. www.Bioinformatics.org **2.** www.bioinfo.mbb.yale.edu/mbb452a/intro/

Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
414445: Elective – IV (Introduction to 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, Cloud Computing

Companion Course, if any:

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	(6 hrs)

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 Operations.

Mapping of Course Outcomes for Unit I	CO1

Unit II	Microservices Architecture and Cloud Native Development	(6 hrs)

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**	**(6 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**	**(6 hrs)**
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**	**(6 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**	**(6 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. PierluigiRiti, “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/
7. https://www.javatpoint.com/kubernetes
8. https://www.javatpoint.com/docker-tutorial
9. https://www.javatpoint.com/jenkins
10. https://www.javatpoint.com/jenkinss
11. https://www.javatpoint.com/ansible
12. https://www.javatpoint.com/selenium-tutorial
13. https://prometheus.io/docs/introduction/overview/
14. https://www.javatpoint.com/jira-tutorial
15. https://www.geeksforgeeks.org/what-is-elastic-stack-and-elasticsearch/

Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
414445: Elective – IV (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, Matlab, Python etc).

Companion Course, if any:

Course Objectives:

1. To review image processing techniques for computer vision.
2. To understand shape and region analysis.
3. To understand three-dimensional image analysis techniques.
4. To understand Feature extraction techniques.
5. To study some applications of computer vision algorithms.

Course Outcomes:

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

CO1. Implement fundamental image processing techniques required for computer vision.
CO2. Apply feature extraction techniques.
CO3. Apply Hough Transform for line, circle, and ellipse detections.
CO4. Understand three-dimensional analysis techniques.
CO5. Develop skills to develop applications using computer vision techniques.

COURSE CONTENTS

Unit I	Fundamentals of Digital Image Processing	(6 hrs)

Introduction to Computer Vision?, Fundamentals Of Image Formation, **Review of Digital image processing:** Introduction, Origin, Applications and Examples of Digital Image Processing, Fundamental steps in Digital Image Processing, Components of Digital Image Processing, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Basic Relationship between pixels, **image processing techniques:** classical filtering operations, Thresholding techniques, edge detection techniques, corner and interest point detection, texture Analysis

Mapping of Course Outcomes for Unit I	CO1

Unit II	Shapes and Regions	(6 hrs)

Binary shape analysis, Connectedness, object labelling and counting, size filtering, distance functions and their uses, skeletons and thinning, Other Measures for Shape Recognition, Boundary pattern analysis: Boundary Tracking Procedures, Centroidal Profiles, Tackling the Problems of Occlusion, Accuracy of Boundary Length Measures, Object segmentation and shape models, Active Contours, Shape Models

Mapping of Course Outcomes for Unit II	CO2

Unit III	Feature Detection and Matching	(6 hrs)

Points and patches: Feature detectors, Feature descriptors, Feature matching, Feature tracking Application: Performance-driven animation, **Edges:** Edge detection, Edge linking, Application: Edge editing and enhancement, Vanishing points, **Application:** Rectangle detection		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Hough Transform**	**(6 hrs)**
Line detection – Hough Transform (HT) for line detection, the foot-of-normal method, Using RANSAC for Straight Line Detection, Hough-Based Schemes for Circular Object Detection, The Problem of Unknown Circle Radius, Overcoming the Speed Problem, Ellipse Detection, Applications, and case study: Human Iris Location, The Generalized Hough Transform (GHT), Use of the GHT for Ellipse Detection, A Graph-Theoretic Approach to Object Location, Possibilities for Saving Computation, Using the GHT for Feature Collation		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**3D Vision and Motion**	**(6 hrs)**
The three-dimensional world, Methods for 3D vision, projection schemes for 3D vision, Shape from X : shape from shading, Photometric Stereo, Shape from texture, Share from focus, The Assumption of Surface Smoothness, Shape from Texture, Use of Structured Lighting, 3D Reconstruction, active range finding, surface representations, point-based representation, volumetric representations, Structure from motion: triangulation, bundle adjustment, Dense motion estimation: translational alignment, parametric motion, spline based motion, Optical flow layered motion		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Computer Vision Applications**	**(6 hrs)**
Application: Photo album – Object detection, Face detection, Pedestrian detection, Face recognition: Eigen faces, Active appearance and 3D shape models, Application: Personal Photo Collections, Category Recognition, Intelligent Photo Editing, Image Search, **Application: Surveillance** – The basic geometry, foreground-background separation, particle filters, Chamfer Matching, Tracking, and Occlusion, combining views from multiple cameras, License Plate Location, Occlusion Classification for Tracking, Human Gait Analysis, In-vehicle vision system: Locating the Roadway, Location of Road Markings, Location of Road Signs, Location of Vehicles, Locating Pedestrians		
Mapping of Course Outcomes for Unit VI	**CO6**	

Textbooks:

1. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 2012.
2. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 3rdEdition, Pearson, ISBN: 978-81-317-2695-2

Reference Books:

1. R. Davies, “Computer & Machine Vision”, Fourth Edition, Academic Press, 2012.
2. R. Szeliski, “Computer Vision: Algorithms and Applications”, Springer 2011.
3. Mark Nixon and Alberto S. Aquado, “Feature Extraction & Image Processing for Computer Vision”, Third Edition, Academic Press, 2012.
4. D. L. Baggio et al., “Mastering OpenCV with Practical Computer Vision Projects”, Packt Publishing, 2012.
5. Jan Erik Solem, “Programming Computer Vision with Python: Tools and algorithms for analyzing images”, O'Reilly Media, 2012.
6. Sudha Challa, “Fundamentals of Object Tracking”, Cambridge University Press, 2011.

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. https://www.fritz.ai/object-detection/
5. https://viso.ai/deep-learning/object-tracking/
6. https://www.pearson.com/us/higher-education/program/Gonzalez-Digital-Image-Processing-4th-Edition/PGM241219.html?tab=resources

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414445: Elective – IV (Wireless Communication)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH): 3 hrs/week	**03 credits**	**Mid_Semester: 30 Marks** **End_Semester: 70 Marks**

Prerequisite Courses: Basic Computer Networks, Computer Networks and Security, Mobile Computing

Companion Course :NA

Course Objectives:

1.To learn fundamental knowledge of wireless communication and generation of cellular network.

2. To understand basic fundamentals of cellular system and LTE Technology.

3. To study various multiple access techniques to access the shared channel.

4.To learn various protocols and applications in wireless communication system.

5. To understand security issues, challenges and tools in wireless communication system.

6. To study recent trends and technologies in wireless communication.

Course Outcomes:

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

CO1: Articulate the fundamental concept of cellular system.

CO2: Analyse the fundamentals of cellular systems.

CO3: Illustrate multiple access technique for effective utilization of spectrum.

CO4: Design and analyse the WAP Programming Model in networking environment.

CO5: Learn and understand security issues, challenges and tools in wireless communication.

CO6: Explore the emerging trends and applications in wireless communication.

COURSE CONTENTS

Unit I	Introduction to Wireless Communication	(6hrs)

Evolution of mobile communications, Types of Wireless Communication: Satellite Communication, Microwave Communication, Infrared, Generation of Cellular network, 2G/3G/4G/5G/6G.

Unit II	Fundamentals of Cellular and LTE Technology	(6hrs)

Cellular system, hexagonal geometry cell and concept of frequency reuse, Need of LTE Long Term Evolution (LTE) Technology fundamentals: Architecture features. **4G:** LTE communication protocol: Protocol model, Air Interface Transport Protocols, Fixed Network Transport Protocols, User Plane Protocols , Signalling Protocols

Unit III	Multiple Access Techniques	(6hrs)

Overview of TDMA (Time Division Multiple Access), and CDMA (Code Division Multiple Access), SDMA (Space Division Multiple Access), IDMA (Interleave Division Multiple Access).
Latest access technologies: MIMO (Multiple Input Multiple Output), OFDM (Orthogonal Frequency Division Multiplexing).

Unit IV	**Wireless Communication Protocols**	**(6 hrs)**

Wireless Application Protocol, The WAP Programming Model, WAP Architecture, Traditional WAP Networking Environment, Wi-Fi Direct, Li-Fi, NFC, SigFox, Z-Wave, LoRaWAN, Thread (based on IEEE 802.15.4), RT Wi-Fi, RTCP, RTSP, SPEED.

Unit V	**Security in Wireless Communication**	**(6 hrs)**

Security Issue and challenges in GSM, 1G, 2G, 3G, 4G.
Multimedia security in 5G and 6G, post-quantum cryptography, Molecular communication, visible light communication (VLC), and distributed ledger (DL). UMTS Security, Bluetooth Security, WEP, WPA2.
Wireless Security Tools: Kismet, URH (Universal Radio Hacker).

Unit VI	**Recent Trends and Applications in Wireless Technology**	**(6 hrs)**

5G NR (New Redio): Working, Benefits.
Holographic MIMO Surfaces for 6G Wireless Networks, Simultaneous Transmission and Reflection (STAR) for 360° Coverage, Quantum technology for 5G/6G Wireless Networks.
Applications of Wireless Technology.

Textbooks:

1. Wireless Communications, T.L. Singal, McGraw Hill Education.
2. Wireless Communications and Networking, Vijay Garg, Morgan Kaufmann Publishers.
3. Wireless Mobile Internet Security, 2nd Edition, Man Young Rhee, A John Wiley & Sons, Ltd., Publication.
4. Principles of Modern Wireless Communication Systems Theory and Practice, 1st Edition, Aditya Jagannatham.
5. 5G Outlook–Innovations and Applications,RamjeePrasad,River Publishers Series in Communications.
6. Designing for Cisco Internetwork Solutions, 2nd Edition, CCDA, Diane Teare, Cisco Press

Reference Books:

1. Cellular Communications: A Comprehensive and Practical Guide, Nishith Tripathi, Jeffery H Reed, Wiley.
2. Wireless Communications- Principles &Practice,Theodore S. Rappaport, Prentice Hall Series.
3. Wireless Communications and Networks", William Stallings, Pearson / Prentice Hall.
4. Adhoc& Sensor Networks Theory and Applications, Carlos de MoraisCordeiro,Dharma Prakash Agrawal, World Scientific,2nd Edition.
5. Wireless Networks, Nicopolitidia, M S Obaidat, GI Papadimitriou, Wiley India (Student Edition, 2010).
6. Wireless Communications, Andrea Goldsmith, Cambridge University Press, 1st South Asian Edition 2009.
7. https://pcefet.com/common/library/books/50/2784_[Christopher_Cox]_An_Introduction_to_LTE_LTE,_LTE(b-ok.org).pdf
8. https://www.techtarget.com/whatis/definition/5G-New-Radio-NR.

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414446: Lab Practice III		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical (PR): 04 hrs/week	**02 Credits**	**OR: 25 Marks** **TW: 25 Marks**

Prerequisites:

1. Data Structures and Files.
2. Database management systems.

Course Objectives:

1. To understand the concepts of information retrieval.
2. To understand the role of clustering in information retrieval.
3. To study indexing structures for information retrieval.
4. To evaluate the performance of the IR system and understand user interfaces for searching.
5. To understand information sharing on the web.
6. To understand the various applications of information retrieval giving emphasis to multimedia and distributed IR, web Search.

Course Outcomes:

On completion of the course, students will be able to

CO1. Understand the concept of Information retrieval and to apply clustering in information retrieval.

CO2. Use appropriate indexing approach for retrieval of text and multimedia data. Evaluate performance of information retrieval systems.

CO3. Apply appropriate tools in analyzing the web information.

CO4. Map the concepts of the subject on recent developments in the Information retrieval field.

Guidelines for Instructor's Manual

The faculty member should prepare the laboratory manual for all the laboratory assignments, and it should be made available to the students and laboratory instructor/Assistant.

Guidelines for Student's Lab Journal

1. Students should submit term work in the form of journals. The Journal consists of prologue, certificate, table of contents, handwritten write-up of each assignment (Title, Objectives, Problem Statement, Theory concept, Outcomes, Conclusion), and printouts of the code written using coding standards, sample test cases etc. To support Go-green, printouts should be asked to any 2 students from each batch. However, all students must submit the soft copy in the form CD/DVD and should be maintained by the batch teacher.
2. Oral Examination will be based on the ISR theory and practical assignments.
3. Students are expected to know the theory involved in the experiment.
4. The oral examination should be conducted if and only if the journal of the candidate is complete in
5. All respects and certified by concerned faculty and head of the department.
6. All the assignments mentioned in the list must be conducted.

Guidelines for Lab /TW Assessment

1. Examiners will assess the term work based on performance of students considering the parameters such as timely completion of practical assignment, methodology adopted for implementation of practical assignment, timely submission of assignment in the form of handwritten write-up along with results of implemented assignment, attendance etc.
2. Examiners will judge the understanding of the concept by asking the questions related to theory & laboratory assignments.
3. Appropriate knowledge of usage of software and hardware related to respective laboratories should be as a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers of the program in a journal may be avoided. There must be hand-written write-ups for every assignment in the journal. The DVD/CD containing student programs should be attached to the journal by every student and the same to be maintained by the department/lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at laboratory.

Guidelines for Laboratory Conduction

All the assignments should be conducted on 64-bit open-source software. C/C++/Java programming language can be used for implementation of assignments if not mentioned. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers of the program in a journal may be avoided. There must be hand-written write-ups for every assignment in the journal. The DVD/CD containing student's programs should be attached to the journal by every student and the same to be maintained by the department/lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at laboratory.

Guidelines for Oral Examination

Both internal and external examiners should jointly conduct Oral examination. During assessment, the Examiners should give the maximum weightage to the satisfactory answer of the question asked. The supplementary and relevant questions may be asked at the time of evaluation to judge the student 's understanding of the fundamentals, effective and efficient implementation.

List of Laboratory Assignments

Group A: CO1, 2, 3

1. Implement Conflation algorithm to generate document representative of a text file.
2. Implement Single-pass Algorithm for clustering of files.(Consider 4 to 5 files)
3. Implement a program for retrieval of documents using inverted files.

Group B: CO3, 5

1. Implement a program to calculate precision and recall for sample input. (Answer set A, Query q_1, Relevant documents to query q_1- Rq_1)
2. Write a program to calculate harmonic mean (F-measure) and E-measure for above example.
3. Implement a program for feature extraction in 2D color images (any features like color, texture etc. and to extract features from input image and plot histogram for the features.

Group C: CO4, 5

1. Build the web crawler to pull product information and links from an e-commerce website. (Python)
2. Write a program to find the live weather report (temperature, wind speed, description, and weather) of a given city. (Python).
3. Case study on recommender system for a product / Doctor / Product price / Music.

Textbooks:

1. Ricardo Baeza-Yates, Berthier Riberio–Neto, Modern Information Retrieval, Pearson Education, ISBN: 81-297-0274-6.
2. C.J. Rijsbergen, Information Retrieval, (www.dcs.gla.ac.uk), Second Edition ISBN:978-408709293.
3. Ryan Mitchell, Web Scraping with Python, O'reilly.
4. Ricci, F, Rokach, L. Shapira, B.Kantor, Recommender Systems Handbook.

Reference Books:

1. ChabaneDjeraba, Multimedia mining: A highway to intelligent multimedia documents, Kulwer Academic Publisher, ISBN: 1-4020-7247-3.
2. V. S. Subrahamanian, Satish K. Tripathi, Multimedia information System, Kulwer AcademicPublisher.
3. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, An Introduction to Information Retrieval, Cambridge University Press, 2008.
4. Marek Kowalkiewicz, Maria E. Orlowska, Tomasz Kaczmarek, Witold Abramowicz, WebInformation Extraction and Integration, Springer New York Publisher.
5. David Grossman, Ophir Frieder, Information Retrieval - Algorithms and Heuristics, Springer,International Edition, ISBN: 978-1-4020-3004-8.
6. Hang Li, Learning to Rank for Information Retrieval and Natural Language. 7. Processing, Morgan& Claypool, ISBN: 9781608457076.
7. Robert Korfhage, Information Storage and Retrieval, John Wiley & Sons, First Edition,ISBN: 9788126507702.
8. https://web.stanford.edu/class/cs276/handouts/EvaluationNew-handout-1-per.pdf.

Virtual Laboratory:

1. http://nlp-iiith.vlabs.ac.in/

Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
414447: Lab Practice IV

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical (PR):02 hrs/week	01 credits	PR: 25 Marks TW: 25 Marks

Prerequisites: Python programming language

Course Objectives:

The objective of the course is

1. To be able to formulate deep learning problems corresponding to different applications.
2. To be able to apply deep learning algorithms to solve problems of moderate complexity.
3. To apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

Course Outcomes:

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

CO1. Learn and Use various Deep Learning tools and packages.
CO2. Build and train a deep Neural Network models for use in various applications.
CO3. Apply Deep Learning techniques like CNN, RNN Auto encoders to solve real word Problems.
CO4. Evaluate the performance of the model build using Deep Learning.

Guidelines for Instructor's Manual

The faculty member should prepare the laboratory manual for all the experiments, and it should be made available to students and laboratory instructor/assistant

Guidelines for Student's Lab Journal

1. Students should submit term work in the form of a handwritten journal based on a specified list of assignments.
2. Practical Examination will be based on the term work.
3. Candidate is expected to know the theory involved in the experiment.
4. The practical examination should be conducted if and only if the journal of the candidate is complete in all respects.

Guidelines for Lab /TW Assessment

1. Examiners will assess the term work based on performance of students considering the parameters such as timely conduction of practical assignment, methodology adopted for implementation of practical assignment, timely submission of assignment in the form of handwritten write-up along with results of implemented assignment, attendance etc.
2. Examiners will judge the understanding of the practical performed in the examination by asking some questions related to theory & implementation of experiments he/she has carried out.
3. Appropriate knowledge of usage of software and hardware related to the respective laboratory should be checked by the concerned faculty member.

Guidelines for Laboratory Conduction

As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers of the program in a journal may be avoided. There must be hand-written write-ups for every assignment in the journal. The DVD/CD containing student's programs should be attached to the journal by every student and the same to be maintained by the department/lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at
Laboratory.

Guidelines for Practical Examination

1. During practical assessment, maximum weightage should be given to satisfactory implementation of the problem statement.
2. Student's understanding of the fundamentals, effective and efficient implementation can be evaluated by asking relevant questions based on implementation of experiments he/she has carried out.

List of Laboratory Assignments

Mapping of course outcomes for Group A assignments: CO1, CO2,CO3,CO4

1. Study of Deep learning Packages: Tensorflow, Keras, Theano and PyTorch. Document the distinct features and functionality of the packages.

Note: Use a suitable dataset for the implementation of following assignments.

2. Implementing Feedforward neural networks with Keras and TensorFlow
    - **a.** Import the necessary packages
    - **b.** Load the training and testing data (MNIST/CIFAR10)
    - **c.** Define the network architecture using Keras
    - **d.** Train the model using SGD
    - **e.** Evaluate the network
    - **f.** Plot the training loss and accuracy

3. Build the Image classification model by dividing the model into following 4 stages:
    - **a.** Loading and preprocessing the image data
    - **b.** Defining the model's architecture
    - **c.** Training the model
    - **d.** Estimating the model's performance

4. Use Autoencoder to implement anomaly detection. Build the model by using:
    - **a.** Import required libraries
    - **b.** Upload / access the dataset
    - **c.** Encoder converts it into latent representation
    - **d.** Decoder networks convert it back to the original input
    - **e.** Compile the models with Optimizer, Loss, and Evaluation Metrics

5. Implement the Continuous Bag of Words (CBOW) Model. Stages can be:
    - **a.** Data preparation
    - **b.** Generate training data
    - **c.** Train model
    - **d.** Output

6. Object detection using Transfer Learning of CNN architectures

a. Load in a pre-trained CNN model trained on a large dataset **b.** Freeze parameters (weights) in model's lower convolutional layers **c.** Add custom classifier with several layers of trainable parameters to model **d.** Train classifier layers on training data available for task **e.** Fine-tune hyper parameters and unfreeze more layers as needed
Reference Books:
1. Hands-On Deep Learning Algorithms with Python: Master Deep Learning Algorithms with Extensive Math by Implementing Them Using TensorFlow **2.** Python Deep Learning, 2nd Edition by Ivan Vasilev , Daniel Slater , GianmarioSpacagna,, Peter Roelants, Valentino Zocca **3.** Natural Language Processing with Python Quick Start Guide by Mirant Kasliwal
Virtual Laboratory:
SPIT's Virtual Labs for AI and Deep Learning: https://vlab.spit.ac.in/ai/

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414448: Project Stage I		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Tutorial (TUT): 02 hrs/week	**02 Credits**	**Term Work: 50 Marks**
Prerequisite Courses, if any: PBL, Seminar, Basic Knowledge of Latest Technologies in IT.		
Companion Course, if any: NOT APPLICABLE		

Course Objectives:

1. To build up their practical experience with implementation and hence develops self-confidence.
2. To generate the opportunities to experience practically the facts learned in various fields together.
3. To improve overall communication skill, Teamwork and Leadership Qualities, professionalism.
4. To apply the knowledge for solving realistic problems.
5. To evaluate alternative approaches and justify the use of selected tools and methods.

Course Outcomes:

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

- **CO1.** To apply knowledge of mathematics, science, and engineering to formulate the Problem statement.
- **CO2.** To design and conduct experiments, as well as to analyze and interpret data.
- **CO3.** Understand the professional and ethical responsibility.
- **CO4.** To communicate effectively.
- **CO5.** Get broad education which is necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- **CO6.** Recognition of the need for, and an ability to engage in life-long learning.
- **CO7.** To use the techniques, skills, and modern engineering tools necessary for engineering practices.
- **CO8.** To design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Introductory Information:

BE Project can be application oriented and/or will be based on some innovative work in recent technologies like IoT, Cloud Computing, Web Technologies, Bio-inspired Algorithms, Artificial Intelligence, Machine Learning, Natural Language Processing, Theoretical Computer Science fundamentals. In Project Phase-I the student will undertake project over the academic year, which will involve the analysis, design of a system or sub system in the area identified earlier in the field of Information Technology and Computer Science and Engineering. The project will be undertaken preferably by a group of 3-4 students who will jointly work and implement the project. The group will select a project based on their internship or Guide can suggest based on recent technologies / Industrial Applications.

Guidelines to Faculty and Students:

1) The Head of the department / Project coordinator shall constitute a review committee (preferably same committee needs to carry throughout the year) for project group; project guide would be one member of that committee by default.

2) For sponsored projects, an employee of the sponsoring organization may be one of the member of review committee.

3) There shall be **TWO** reviews in Project phase –I (in semester-I) by the review committee.

4) The Project Review committee will be responsible for evaluating the timely progress of the projects. It is suggested to evaluate the skills learned by the students in their PBL (in their previous years).

5) Student should identify project of enough complexity, which has at least 4-5 major functionalities.

6) Student should adopt skills learned in Software Engineering / Software Architecture to identify stakeholders, actors, Architectural Styles etc... and write detail problem statement for the system.

7) Review committee should finalize the scope of the project.

8) If change in project topic is unavoidable then the students should complete the process of Project approval by submitting synopsis along with the review of important papers which should be approved by review committee.

9) Every student of the project group shall make presentation on the progress made by them before the committee during each review. Each student/group is required to give presentation as part of review for 10 to 15 minutes followed by a detailed discussion and query session.

10) Students need to note down the queries raised during review(s) and comply the same in the next review session.

11) The record of the remarks/suggestions of the review committee (project dairy) should be properly maintained and should be made available at the time of university examination.

12) Project group needs to present / publish TWO papers (One in each semester, at least one paper should be in **UGC – Care journal**).

- **a)** Paper must be checked for Plagiarism by any open software.
- **b)** One paper during first semester which includes Literature Survey and Detailed design components of the Project Statement.
- **c)** One paper during second semester which includes Methodologies / Algorithms implemented, Results obtained, Analysis of results and conclusion.

13) Project report must also be checked for Plagiarism.

14) 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.

Review 1: Synopsis –

Points to be covered:

1) The precise problem statement/title based on literature survey and feasibility study.

2) Motivation, objectives, and scope of the project.

3) List of required hardware, software, or other equipment for executing the project, test Environment/tools, cost and software measurement/human efforts in hours.

4) System overview- proposed system and expected outcomes.

5) Architecture and initial phase of design (DFD).

Review 2: Requirement and Design Specification

Points to be covered:

1) User and System Requirements.
2) Functional and Non-functional Requirements.
3) SRS Document, Writing structures SRS as per Problem Statement.
4) Requirement Analysis / Models.
5) UML/ER Diagrams.
6) Detail architecture / System design/ Algorithms with analysis / Methods / Techniques.
7) Need to discuss Design models and Component level designs.
8) Detailed Design (DFD levels as per the problem statement).
9) At least 30-40% coding documentation with at least 3 to 4 working modules.
10) Identification of test to be essential and appropriate (to be implement later).
11) Project plan.

Evaluation Criteria:

Following criteria and weightage is suggested for evaluation of Project-Phase I Term Work.

1) Originality of Problem Statement: 10% (05 Marks)
2) Depth of Understanding the Problem Statement: 10% (05 Marks)
3) Concreate Literature Survey with identified gaps in all referred papers: 10% (05 Marks)
4) Design and Analysis of Algorithm / Model / Architecture / System: 40% (20 Marks)
5) Representation of results using suitable tools like tabulation, graph etc: 10% (05 Marks)
6) Presentation Skill: 10% (05 Marks)
7) Report preparation and Paper publication: 10% (05 Marks)

Project report contains the details as Follows:

Project report must have:

i. Certificate from the institute
ii. Certificate sponsoring organization (If any)
iii. Acknowledgement
iv. Abstract
v. Contents
vi. List of Abbreviations (As applicable)
vii. List of Figures (As applicable)
viii. List of Graphs (As applicable)
ix. List of Tables (As applicable)

1. Introduction and aims/motivation and objectives.
2. Literature Survey (with proper citation).
3. Problem Statement/definition.
4. Software Requirement Specification (In SRS Documentation only).
5. Flowchart
6. Project Requirement specification.
7. Proposed system Architecture.
8. High level design of the project (DFD,UML, ER Diagrams).
9. System implementation-code documentation: Algorithm style, Description of detailed methodologies, protocols used etc..as applicable.
10. Test cases.
11. Proposed GUI/Working modules/Experimental Results (Module wise if available) in suitable format.
12. Project Plan.
13. Conclusions.
14. Bibliography in IEEE format.

Appendices:

A. Plagiarism Report of Paper and Project report from any open-source tool.
B. Base Paper(s) [If any].
C. Tools used / Hardware Components specifications [If any].
D. Published Papers and Certificates.

Use appropriate plagiarism tools, reference managers, Latex for efficient and effective project writing.

Reference Books:

1. UML2 Bible by Tom Pender, Wiley India Pvt. Limited 2011
2. Applying UML and Patterns Second Edition by Craig Larman, Pearson Education
3. UML 2 and the Unified Process, Second Edition, JIM Arlow, Ila Neustadt, Pearson
4. Design Patterns: Elements of Reusable Object-Oriented Software, Erich Gamma, Pearson
5. Design Patterns in Java Second Edition by Steven John Metsker, Pearson

All the assignments should be conducted on Latest version of Open-Source Operating Systems, tools and Multi-core CPU supporting Virtualization and Multi-Threading

Savitribai Phule Pune University, Pune B.E Information Technology (2019 Course) 414449A: Audit Course 7 Copyrights and Patents		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory(TH): 01 hrs/week	**Non-Credit**	**Audit Course**

Prerequisite Courses, if any:

Course Objectives:

1. To introduce fundamental aspects of Intellectual Property Rights (IPR)
2. To study the awareness about Copyrights, Trademark and Trade Secrets.

Course Outcomes:

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

CO1. Understand the concepts of Intellectual Property Rights.

CO2. Understand the knowledge about Copyrights and Trademark.

CO3. Understand the knowledge how to protect trade secrets.

COURSE CONTENTS

Unit I	Introduction to Intellectual Property Law	(03 hrs)
The Evolutionary Past - The IPR Tool Kit- Para -Legal Tasks in Intellectual Property Law – Ethical obligations in Para Legal Tasks in Intellectual Property Law. Introduction to Cyber Law – Innovations and Inventions Trade related Intellectual Property Right		
Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**Trademark**	**(03 hrs)**
Trademark Registration Process – Post registration Procedures – Trade mark maintenance - Transfer of Rights - Inter partes Proceeding – Infringement - Dilution Ownership of Trade mark – Likelihood of confusion - Trademarks claims – Trademarks Litigations – International Trademark Laws.		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Copyrights**	**(03 hrs)**
Principles of Copyright Principles -The Subjects Matter of Copy right – The Rights Afforded by Copyright Law – Copy right Ownership, Transfer, and duration – Right to prepare Derivative works – Rights of Distribution – Rights of Perform the work Publicity Copyright Formalities and Registrations - Limitations - Copyright disputes and International Copyright Law – Semiconductor Chip Protection Act		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Introduction to Trade Secret**	**(03 hrs)**

Maintaining Trade Secret – Physical Security – Employee Limitation - Employee confidentiality agreement - Trade Secret Law - Unfair Competition – Trade Secret Litigation – Breach of Contract – Applying State Law

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

Textbooks:

1) DebiragE.Bouchoux: "Intellectual Property". Cengage learning, New Delhi
2) M.Ashok Kumar and Mohd.Iqbal Ali: "Intellectual Property Right" Serials Pub.
3) Cyber Law. Texts & Cases, South-Western's Special Topics Collections
4) Prabhuddha Ganguli: 'Intellectual Property Rights" Tata Mc-Graw –Hill, New Delhi
5) https://nptel.ac.in/courses/109105112

Evaluation

Students should select any one of the topics in a group of 3 to 5. Students should submit a written Report. Make a presentation on the topic. Report will be evaluated by the faculty as per rubrics defined by them at start of course.

Savitribai Phule Pune University, Pune

B.E Information Technology (2019 Course)

414449B: Audit Course 7

Stress Management By Yoga

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory(TH): 01 hrs/week	Non-Credit	Audit Course

Prerequisite Courses, if any:

Course Objectives:

To achieve overall health of body and mind

Course Outcomes:

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

- **CO1.** Understand the reasons for Stress**.**
- **CO2.** Understand the role of Yoga.
- **CO3.** Develop healthy mind in a healthy body.
- **CO4.** Develop overall efficiency.

COURSE CONTENTS

Unit I	Introduction to Stress	(03 hrs)
Meaning and Definition of Stress. Types: Eutress, Distress, Anticipatory Anxiety, Intense Anxiety and Depression. Meaning of Management – Stress Management. Physiology of Stress on: Autonomic Nervous System.		
Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**Introduction to Yoga**	**(03 hrs)**
Meaning and definition of Yoga – aims & objectives of yoga, Definitions of Eight parts of yog. (Ashtanga), Concept of Stress according to Yoga.		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Asan and Pranayam**	**(03 hrs)**
Asan - Various yog poses and their benefits for mind & body. Pranayam - Regularization of breathing techniques and its effects-Types of pranayam.		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Effect of Yoga**	**(03 hrs)**
Impact of Yoga on Muscular system, Respiratory System, Circulatory system,Nervous system, Digestive system and Endocrine system		
Mapping of Course Outcomes for Unit IV	**CO4**	

1. Textbooks:
2. 'Yogic Asanas for Group Tarining-Part-I": Janardan Swami Yogabhyasi Mandal, Nagpur 3. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (PublicationDepartment), Kolkata 4. Iyengar, BKS., (2003). The Art of Yoga. New Delhi: Harper Collins Publishers. 5. Ravishankar.N.S., (2001). Yoga for Health. New Delhi: Pustak Mahal. 6. https://nptel.ac.in/courses/121105009 7. https://onlinecourses.swayam2.ac.in/aic19_ed29/
Evaluation
Students should select any one of the topics in a group of 3 to 5. Students should submit a written Report. Make a presentation on the topic. Report will be evaluated by the faculty as per rubrics defined by them at start of course.

Savitribai Phule Pune University, Pune

B.E Information Technology (2019 Course)

414449C: Audit Course 7

English for Research Paper Writing

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory(TH): 01 hrs/week	Non-Credit	Audit Course

Prerequisite Courses, if any:

Course Objectives:

1. To improve writing skills and level of readability.
2. Learn about what to write in each section.
3. Summarize the skills needed when writing a research paper.
4. To study the good quality of paper at very first-time submission.

Course Outcomes:

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

CO1. Understand that how to improve writing skills and level of readability.

CO2. Identify and categorize about what to write in each section.

CO3. Ensure the good quality of paper at very first-time submission.

COURSE CONTENTS

Unit I	Introduction to Research Paper Writing	(03hrs)
Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.		
Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**Presentation Skills**	**(03 hrs)**
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Writing Problem Solution - Texts**	**(03 hrs)**
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, and skills are needed when writing the Conclusions.		
Mapping of Course Outcomes for Unit III	**CO2, C03**	
Unit IV	**VERIFICATION SKILLS**	**(03 hrs)**
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission.		

Mapping of Course Outcomes for Unit IV	CO3

Textbooks:

1) Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press Model Curriculum of Engineering & Technology PG Courses [Volume -II]
2) Goldbort R (2006) Writing for Science, Yale University Press
3) Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4) Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht HeidelbergLondon, 2011
5) https://nptel.ac.in/courses/110105091

Evaluation

Students should select any one of the topics in a group of 3 to 5. Students should submit a written research Report /paper or make a presentation on the topic. Report/Presentation will be evaluated by the faculty as per rubrics defined by them at start of course.

SEMESTER – VIII

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) **414450: Distributed Systems**		
Teaching Scheme: 03 Hrs/Week	**Credit Scheme:**	**Examination Scheme:**
Theory (TH): 03 hrs/week	**03 Credits**	**Mid_Semester:30 Marks** **End_Semester: 70 Marks**

Prerequisite Courses:
Operating System, Computer Network, Data Structure and Algorithm

Companion Course, if any:
NA

Course Objectives:

1. To learn the principles, architectures and programming models used in distributed systems.
2. To understand the fundamentals and knowledge of the Middleware of distributed systems
3. To gain knowledge of working components and fault tolerance of distributed systems.
4. To understand the significance of agreement, fault tolerance and recovery protocols in Distributed Systems.
5. To make students aware about distributed and multimedia file systems and web systems.
6. Create an awareness of Emerging trends in distributed computing.

Course Outcomes:

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

- **CO1.** Demonstrate the core concepts of distributed systems.
- **CO2.** Understand the concept of middleware of distributed systems.
- **CO3.** Understand Inter-process communication methods and analyze different coordination algorithms.
- **CO4.** Comprehend the importance of replication to achieve fault tolerance in distributed systems.
- **CO5.** Analyze the design and functioning of existing distributed file systems, distributed multimedia, and distributed web-based systems.
- **CO6.** Understand various Recent Trends in distributed systems.

COURSE CONTENTS

Unit I	**Introduction to Distributed Systems**	**(6 hrs)**
Introduction: Network operating System VS Distributed operating systems, Characteristics, Design goals, challenges of Distributed Systems, Examples of Distributed Systems, Trends in Distributed systems: Pervasive networking and the modern Internet, Mobile and ubiquitous computing, Focus on resource sharing Distributed Computing Models: Physical, Architecture and Fundamental models • **Case Study:** WWW 1.0,2.0, 3.0		
Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**Middleware**	**(6 hrs)**

Introduction to middleware, middleware Framework, Role of middleware, Examples of Middleware, Origins of middleware, Architecture vs Middleware, RMI, CORBA, General Approaches to adaptive software, Types of middleware-messages oriented middleware, intelligent middleware, content centric middleware, middleware protocol, middleware Services, Distributed computing Environment (DCE), middleware Issues, middleware Analyst **Case Study: -** XML Based middleware		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Inter-Process Communication**	**(6 hrs)**
IPC: Introduction, Layered protocols, API for internet protocols, IPC through shared memory, external data representation and marshaling, Types of communication, inter process communication, multicast communication, message-oriented communication, MPI, network virtualization, overlay networks **Coordination:** Clock synchronization, logical clocks, mutual exclusion, election algorithms, Gossip based coordination **Case Study:** IBM WebSphere Message Queuing		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Replication and Fault Tolerance**	**(6 hrs)**
Replication: Reasons for replication, Replica management – Finding the best server location, Content replication and placement, Content distribution, Managing replicated objects Consistency protocols: Primary based protocols, replicated write protocols **Fault Tolerance:** Introduction to fault tolerance, Reliable client server communication, Reliable group communication, distributed commit, Recovery – Check pointing, Message logging **Case Study:** Caching and replication in web		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Distributed Files, Multimedia and Web Based System**	**(6 hrs)**
Distributed Files: Introduction, File System Architecture, Sun Network File System and HDFS. **Distributed Multimedia Systems:** Characteristics of Multimedia Data, Quality of Service Management, Resource Management **Distributed Web Based Systems:** Architecture of Traditional Web-Based Systems, Apache Web Server, Web Server Clusters, Communication by Hypertext Transfer Protocol, Synchronization, Web Proxy Caching **Case Study:** The Global Name Service, The X.500 Directory Service, BitTorrent		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Recent Trends in Distributed Systems**	**(6 hrs)**

Recent Trends: Introduction, Portable and handheld Devices, Wearable devices, Devices embedded in appliances, Parallel Virtual Machine (PVM), Jini, Service Oriented Architecture, The Future of Recent Trends.

Tools for Distributed System Monitoring: Prometheus, Zabbix, Nagios

- **Case Studies:** Mach, Chorus

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

Textbooks:

1. Distributed Systems: Concepts and Design by George Coulouris, J Dollimore and Tim Kindberg,
2. Pearson Education, ISBN: 9789332575226, 5th Edition, 2017.
3. Distributed Systems, Maarten van Steen, Andrew S. T,ThirdeditionVersion.
4. Andrew S. Tanenbaum, Maarten van Steen, PHI ,2nd Edition, ISBN: 978-0130888938
5. Distributed Operating Systems: Concepts and Design by P. K. Sinha, PHI, ISBN: 978-0780311190

Reference Books:

1. Distributed Computing, Sunita Mahajan and Seema Shah, Oxford University
2. Distributed Computing, Fundamentals, Simulations and Advanced topics, 2nd Edition,
3. HagitAttiya and Jennifer Welch, Wiley India
4. Tool for Distributed Systems Monitoring, Łukasz KUFEL, Foundation of Computing and Decision Sciences, Vol 41(4), 2016, e-ISSN 2300-3405, DOI:10.1515/fcdc-2016-0014

E Books / E Learning References:

1. http://home.mit.bme.hu/~meszaros/edu/oprendszerek/segedlet/elosztott/distributed-systems-survey.pdf
2. http://home.mit.bme.hu/~meszaros/edu/oprendszerek/segedlet/elosztott/DisSysUbiCompReport.html

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414451: Elective-V (Software Defined Network)		
Teaching Scheme:	**Credit:**	**Examination Scheme:**
Theory (TH):03 hrs/week	**03 Credits**	**Mid_Sem : 30 Marks** **End_Sem : 70 Marks**

Prerequisite Courses:

Prior knowledge of fundamentals of Computer Network and Cloud Computing.

Course Objectives:

1. To understand the Need, History of SDN and Methods of API in SDN.
2. To understand role of Open Flow protocol and SDN Controllers and Use cases.
3. Acquire knowledge of Virtualization and its basic principles and understand role of Cloud Computing using SDN
4. To learn concept of data centre in SDN
5. To learn about security issues and challenges in SDN.
6. To learn applications and future of SDN.

Course Outcomes:

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

CO1. Acquire fundamental knowledge of SDN exploring the need, characteristics, and architecture of SDN and methods of API's in SDN.
CO2. Recognize Open Flow protocols and its forwarding, pipeline model and use cases of SDN controller.
CO3. Demonstrate virtualization and Cloud computing services of SDN.
CO4. Comprehend IT Infrastructure and understand the data center in SDN.
CO5. Analyse various security issues and challenges in SDN.
CO6. Comprehend SDN application areas and future.

COURSE CONTENTS

Unit I	**Introduction to Software Defined Networking (SDN)**	**(6hrs)**

Introduction of SDN -Definition, Need of SDN, History of Software Defined Networking (SDN), Fundamental characteristics of SDN, Advantages and Disadvantages of SDN, Distributed control planes, Load Balancing, Centralized control planes, The Evolution of Networking Technology.

Alternate SDN Methods- SDN via Existing APIs, SDN via Hypervisor-Based Overlay Networks. Traditional Switch Architecture-Roles and Separation of data, control and management Planes, SDN API's (Northbound API's, Southbound API's), SDN Devices.

Unit II	**Open Flow & SDN Controllers**	**(6hrs)**

Definition, OpenFlow architecture, Flow & Group Table types, Hybrid Approaches, The OpenFlow forwarding and pipeline model, OpenFlow Advantages and Limitations, OpenFlow Protocol.

SDN Controllers -SDN OpenFlow Controllers: Open-Source Controllers - NOX, POX, Use Case: FloodLight, Mininet, Implementing software-defined network (SDN) based firewall.

Unit III	**Virtualization and Cloud Computing**	**(6hrs)**

Virtualized Network Functions -Background and Motivation for NFV, Virtual Machines, NFV Concepts - NFV Reference architecture, NFV Infrastructure, Virtualized Network Functions (NFV) - Management and Orchestration, Comparison between SDN and NFV, NFV Use Cases - SDN and NFV.
Cloud Computing -Cloud Computing and Resource Virtualization, SDN Applications in Network Virtualization, Cloud Network Virtualization using SDN- Synergy between SDNs and clouds, Integration Architectures, Network as a Service (NaaS) supported by SDN, Security as a Service (SecaaS) using SDN.

Unit IV	SDN in Data Center	(6hrs)

Data Center- Definition, Data Center Demands, Tunneling Technologies for the Data Center, Path technologies in data centers, Ethernet fabrics in Data centers, SDN Use Cases in the Data Center, Multitenant and Virtualized Multitenant Data Center – SDN Solutions for the Data Center Network

Unit V	SDNsecurity	(6hrs)

Security Characteristics of SDN, Security Analysis and Potential attacks in SDN,Security Principles of SDN, Solutions to the security issues in SDN, Network Security enhancement using the SDN Framework – Issues and Challenges, Threats to SDN -Networks, Controllers, Applications.

Unit VI	SDN Applications and SDN Future	(6hrs)

SDN applications-Reactive versus Proactive Applications, Analysing Simple SDN Applications, A Simple Reactive Java Application, Using the Floodlight Controller, Using the Open Daylight Controller, Access Control for the Campus, Traffic Engineering for Service Providers.
SDN Future -Potential Novel Applications of Open SDN-Managing Non-traditional Physical Layer Links, Applying Programming Techniques to Networks, Security Applications, Roaming in Mobile Networks, Traffic Engineering in Mobile Networks.

Textbooks:

1. Paul Goransson and Chuck Black, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann, 2014, ISBN: 9780124166752, 9780124166844.
2. SiamakAzodolmolky, “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, 978-1-4493-4230-2.

Reference Books:

1. Vivek Tiwari, “SDN and OpenFlow for Beginners”, Digital Services, 2013, ISBN: 10: 1-940686-00-8, 13: 978-1-940686-00-4.
2. Fei Hu, “Network Innovation through OpenFlow and SDN: Principles and Design”, CRC Press, 2014, ISBN: 10: 1466572094.
3. Open Networking Foundation (ONF) Documents, https://www.opennetworking.org, 2015.

E Books / E Learning References:

1. https://www.sdxcentral.com/sdn/definitions/software-defined-networking-tutorial/
2. http://sbrc2015.ufes.br/wp-content/uploads/Ch1.pdf
3. http://pure.qub.ac.uk/files/16066743/SDN_Security_Survey_FinalFile.pdf

Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
414451: Elective- V (Social Computing)

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

Prerequisite Courses:

- Basic Knowledge of Graphs
- Networking
- Data Mining and Analytics

Course Objectives:

1) To understand foundations of Social Media Analytics.
2) To understand network measures for social data.
3) To Visualize and understand the data mining aspects in social networks.
4) To understand social similarities in social groups
5) To understand behavioral part of web applications for Analysis.
6) To analyze the data available on any social media applications.

Course Outcomes:

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

CO1. Understand basics of Social Media Analytics
CO2. Correlate Network Measures for Social Media Data
CO3. Visualize mining in social media data
CO4. Discuss the Social Similarities
CO5. Interpret social media behavior
CO6. Apply Social Media Computations for Google+

COURSE CONTENTS

Unit I	Introduction to social media	(6 hrs)

The foundation for analytics, social media data sources, defining social media data, data sources in social media channels, Estimated Data sources and Factual Data Sources, Public and Private data, data gathering in social media analytics.

Mapping of Course Outcomes for Unit I	CO1

Unit II	Network Measures	(6hrs)

Centrality: Degree Centrality, Eigenvector Centrality, Katz Centrality, PageRank, Betweenness Centrality, Closeness Centrality, Group Centrality.

Transitivity and Reciprocity, Balance and Status, Similarity: Structural Equivalence, Regular Equivalence

Information Diffusion in social media: Herd Behaviour, Information Cascades, Diffusions in Cascades, Epidemics

Mapping of Course Outcomes for Unit II	CO2

Unit III	Mining in social media	(6 hrs)

Data Mining in Social Media: Motivations for Datamining in Social Media, Data mining Methods for Social Media, Data Representation, Data mining- A Process, Examples- Social Networking Sites, The Blogosphere
Text mining in Social Networks: Keyword Search, Query Semantics and Answer Ranking, Keyword search over XML and relational data, Keyword search over graph data, Classification Algorithms, Clustering Algorithms, Transfer Learning in Heterogenous Networks

Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Influence and Homophily**	**(6 hrs)**
Influence and Homophily: Measuring Assortativity, Influence, Homophily, Distinguishing Influence and Homophily: Shuffle test, Edge-Reversal Test, Randomization Test		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Social Media Behavior**	**(6 hrs)**
Recommendation in social media: Challenges, Classical Recommendation Algorithms, Recommendation using Social Context, Evaluating Recommendations, Behaviour Analytics: Individual Behaviour, Collective Behaviour		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Case Study**	**(6 hrs)**
Mining Google+: Overview, Exploring Google+ API, A Whiz bang Introduction to TF-IDF, Query human Language Data with TF-IDF Mining Web pages: Scraping, Parsing, and crawling Web, Discovering Semantics by Decoding syntax, Entity-Centric Analysis, Quality of Analysis for Processing Human Language Data		
Mapping of Course Outcomes for Unit VI	**CO6**	

Textbooks:

1. Alex Gonçalves: Social Media Analytics Strategy, Using Data to Optimize Business Performance, Apress
2. Raza Zafarani, Mohammad Ali Abbasi, Huan Liu: Social Media Mining, Cambridge University Press April 2014
3. Mathew A Russell, Mining the Social Web, Data Mining, Facebook, Twitter, LinkedIn, Google+, GITHUB and More, 2nd Edition, OReilly.

Reference Books:

1. Charu C. Aggarwal, Social Network Data Analytics, Springer, ISBN: 978-1-4419-8461-6.
2. Marshall Sponder, Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics, McGraw Hill Education, 978-0-07-176829-0.
3. Matthew A. Russell, Mining the Social Web, O'Reilly, 2nd Edition, ISBN:10: 1449367615.
4. Jiawei Han University of Illinois at Urbana-Champaign Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2nd Edition, ISBN: 13: 978-1-55860-901-3 ISBN: 10: 1-55860-901-6.
5. Bing Liu, Web Data Mining: Exploring Hyperlinks, Contents and Usage Data, Springer, 2 nd Edition, ISBN: 978-3-642-19459-7.

E Books / E Learning References:

https://emplifi.io/resources/blog/social-media-analytics-the-complete-guide

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414451: Elective V (Natural Language Processing)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH):03hrs/week	**03 Credits**	**Mid_Semester: 30 Marks** **End_Semester: 70 Marks**
Prerequisite Courses, if any: Theory of Computer Science		
Companion Course, if any:		

Course Objectives:

This course will enable students to

1. Learn the techniques in natural language processing.
2. Be familiar with the natural language generation.
3. Be exposed to Text Mining.
4. Understand the information retrieval techniques

Course Outcomes:

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

CO1. Understand and analyze the natural language text and model.

CO2. Analyze the natural language syntactically.

CO3. Analyze and study natural language logically.

CO4. Process the natural language text based on relations and knowledge.

CO5. Evaluate the natural language text using models and apply modeling techniques for automatic document separation and text mining.

CO6. Apply information retrieval techniques.

COURSE CONTENTS

Unit I	**Introduction to NLP**	**(6hrs)**
Overview and language modelling: Overview: Origins and challenges of NLP- Language and Grammar-Processing Indian Languages- NLP Applications Information Retrieval. Language Modelling: Various Grammar- based Language. Models-Statistical Language Model.		
Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**Word Level Analysis and Syntactic Analysis**	**(6 hrs)**
Word Level Analysis: Regular Expressions- Finite-State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging. **Syntactic Analysis:** Context-free Grammar-Constituency- Parsing-Probabilistic Parsing,		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Semantic Analysis**	**(6hrs)**

Introduction, Meaning Representation, Lexical Semantics, Ambiguity, Word Sense Disambiguation Discourse Processing: Introduction, Cohesion, Reference Resolution, Discourse Coherence and Structure		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Text Processing: Relations and Knowledge**	**(6hrs)**
Extracting Relations from Text: From Word Sequences to Dependency Paths: Introduction, Subsequence Kernels for Relation Extraction, A Dependency-Path Kernel for Relation Extraction and Experimental Evaluation. Mining Diagnostic Text Reports by Learning to Annotate Knowledge Roles: Introduction, Domain Knowledge and Knowledge Roles, Frame Semantics and Semantic Role Labelling, Learning to Annotate Cases with Knowledge Roles and Evaluations. **A Case Study in Natural Language Based Web Search:** In Fact System Overview, The GlobalSecurity.org Experience.		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Document Processing and Text Mining**	**(6hrs)**
Automatic Document Separation: A Combination of Probabilistic Classification and Finite-State Sequence **Modelling:** Introduction, Related Work, Data Preparation, Document Separation as a Sequence Mapping Problem, Results. Evolving Explanatory Novel Patterns for Semantically Based Text Mining: Related Work, A Semantically Guided Model for Effective Text Mining		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Information retrieval and lexical resources**	**(6hrs)**
Information Retrieval: Design features of Information Retrieval Systems-Classical, non-classical, Alternative Models of Information Retrieval – valuation Lexical Resources: World Net-Frame Net-Stemmers-POS Tagger- Research Corpora. **Model:** Introduction to iSTART		
Mapping of Course Outcomes for Unit VI	**CO6**	

Textbooks:

1. U.S. Tiwary, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2008.
2. Anne Kao and Stephen R. Poteet (Eds), “Natural LanguageProcessing and Text Mining”, Springer-Verlag London Limited 2007.

Reference Books:

1. Allen James, Natural Language Understanding, Pearson India, 2nd Edition ISBN: 9788131708958, 8131708950
2. James H. Martin, Daniel Jurafsky, Speech and Language Processing Pearson 1stAddition, ISBN 9789332518414
3. Hobson Lane, Cole Howard, Hannes Hapke. 2019. Natural Language Processing in Action. Live Book

E Books / E Learning References:
1. https://onlinecourses.nptel.ac.in/noc20_cs87/preview 2. https://onlinecourses.nptel.ac.in/noc19_cs56/preview 3. Virtual Lab :- (Natural Language Processing Lab) http://nlp-iiith.vlabs.ac.in/

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414451: Elective-V (Soft Computing)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH):3 hrs/week	**03 credits**	**Mid_Semester:30 Marks** **End_Semester: 70 Marks**

Prerequisite Courses, if any: Linear Algebra and Calculus, Probability Theory

Companion Course, if any: -

Course Objectives:

The objective of this course is to

1. Get familiarize with soft computing concepts
2. Understand use of Neural networks, fuzzy logic, GA, Hybrid Systems for problem solving

Course Outcomes:

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

- **CO1.** Learn soft computing techniques and their roles in problem solving.
- **CO2.** Understand and Analyze various Artificial neural network techniques
- **CO3.** Understand and define the fuzzy systems for problem solving.
- **CO4.** Understand and apply the concepts of genetic algorithms for problem solving.
- **CO5.** Identify and select a suitable Soft Computing method to solve the problem
- **CO6.** Identify and understand the role of soft computing models in various applications

COURSE CONTENTS

Unit I	Introduction	(6 hrs)
Basic concept of Soft Computing, Historical Development, Definitions, Soft Computing characteristics, advantages and disadvantages, Constitutes of Soft Computing : Fuzzy Logic and Computing, Neural Computing, Evolutionary Computing, Genetic Algorithms, Probabilistic Reasoning.		
Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**Artificial Neural Networks**	**(8 hrs)**
Fundamentals: Biological Neurons and Artificial neural network, model of artificial neuron. Neural Network Architectures, Neural Network models: Perceptron, Adaline, and Madaline networks; single layer network; Back propagation and multi-layer networks. **Learning Methods:** Hebbian, competitive, Boltzman etc., Competitive learning networks: Kohonenself-organizing networks, Hebbian learning; Hopfield Networks.		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Fuzzy Logic and Fuzzy Systems**	**(6hrs)**

Fuzzy logic, fuzzy sets and operations, fuzzy relations, Fuzzy arithmetic, and fuzzy measures. Fuzzy to Crisp conversions: Lambda Cuts for fuzzy sets, fuzzy Relations, Defuzzification methods. Fuzzy rules and reasoning, Fuzzy inference systems- Mamdani Fuzzy Models– Sugeno Fuzzy Models, Fuzzy modeling and decision making, Neuro-fuzzy modeling.		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Genetic Algorithms**	**(6 hrs)**
Introduction, Encoding, Operators of Genetic Algorithm, Basic Genetic Algorithm, Simple GA, crossover and mutation, Multi-objective Genetic Algorithm (MOGA) Applications of Genetic Algorithm: genetic algorithms in search and optimization, GA based clustering Algorithm, Image processing and pattern Recognition.		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Hybrid Systems**	**(6 hrs)**
Introduction, Neuro-Fuzzy modeling: Genetic Algorithm based Back-propagation Network, Fuzzy – Backpropagation, Fuzzy Logic Controlled Genetic Algorithms, Simplified Fuzzy ARTMAP, Case studies.		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Applications Of Soft Computing Techniques**	**(6 hrs)**
Applications of fuzzy in pattern recognition-character recognition. Applications of evolutionary computing in Image processing and computer vision, soft computing in mobile ad-hoc networks, soft computing in Information Retrieval and Semantic web, Soft Computing in Software Engineering, Simulated Annealing, Tabu search, Ant colony optimization (ACO), Particle Swarm Optimization (PSO).		
Mapping of Course Outcomes for Unit VI	**CO6**	

Textbooks:

1. S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley publications, 2nd Edition.
2. J. S. R. Jang, C. T. Sun, E. Mizutani, 'Neuro-Fuzzy and Soft Computing- A computational approach to Learning and Machine Intelligence' PHI

Reference Books:

1. David E. Goldberg, Genetic Algorithms - Pearson Education, 2006
2. Satish Kumar, "Neural Networks - A Classroom Approach", Tata McGraw,Hill
3. Timothy J. Ross, “Fuzzy Logic with Engineering Applications,” 3rd ed. Wiley India.
4. Samir Roy, Udit Chakroborthy, —Introduction to soft computing - neuro-fuzzy and genetic algorithm, Pearson Education, 2013

E-Resources

1. Introduction to Soft Computing: NPTEL- https://onlinecourses.nptel.ac.in/noc20_cs17/preview
2. Virtual Lab (Soft Computing Tools in Engineering lab) :- http://vlabs.iitkgp.ac.in/scte/

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414451: Elective V (Game Engineering)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH):3 hrs/week	**03 credits**	**Mid_Semester:30 Marks** **End_Semester: 70 Marks**

Prerequisite Courses: Discrete Structures.

Companion Course, if any:

Course Objectives:

1. To develop strong conceptual underpinnings of games.
2. To understand complete structure of a computer game and the major components of a game engine.
3. To develop creativity and individuality in problem solving and performing tasks.
4. To learn how to design challenges, rules and feedbacks when implementing and aligning the game activities with goals.
5. To develop competences necessary for graduate students to be employed in the game development industry.

Course Outcomes:

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

CO1. Describe fundamentals of game engineering and the social- ethical issues in game development.
CO2. Develop creative and critical thinking skills for designing compelling games.
CO3. Apply game mechanics to make game more enjoyable.
CO4. Analyze Games over Networks and Peer Effects.
CO5. Demonstrate an understanding of various tools that are used in game development.
CO6. Apply mathematical and game programming knowledge and skills to solve development tasks.

COURSE CONTENTS

Unit I	An Introduction to Games and Gaming	(6 hrs)

Introduction: Definition of Gamification, Why Gamify, Examples and Categories, Gamification in Context, Resetting Behaviour, Replaying History, Gaming foundations: Fun Quotient, Evolution by loyalty, status at the wheel, the House always wins.

Mapping of Course Outcomes for Unit I	CO1, CO2, CO6

Unit II	Developing Thinking	(7 hrs)

Re-framing Context: Communicology, Apparatus, and Post-history, Concepts Applied to Video games and Gamification, Rethinking 'playing the game' with Jacques Henriot, To Play Against: Describing Competition in Gamification, Player Motivation: Powerful Human Motivators, Why People Play, Player types, Social Games, Intrinsic verses Extrinsic Motivation, Progression to Mastery.
Case Study: Wordle

Mapping of Course Outcomes for Unit II	CO1, CO2,CO6

Unit III	Game Mechanism	(6 hrs)
Reclaiming Opposition: Counter gamification, Gamed Agencies: Affectively Modulating Our Screen-and App-Based Digital Futures, Remodelling design, Game Mechanics: Designing for Engagement, Game Mechanics and dynamic. Case Study: Cricket League		
Mapping of Course Outcomes for Unit III	**CO1, CO2, CO3,CO6**	
Unit IV	**Rules of Play - Game Design Fundamentals**	**(6 hrs)**
Rules of Play: Defining Rules, Rules on Three Levels, The Rules of Digital Games Network effects and games over networks: Positive and negative externalities, Utility-based resource allocation, Selfish routing, Wardrop and Nash equilibrium, partially optimal routing, Network pricing, Competition and implications on network performance, Strategic network formation, Price of anarchy.		
Mapping of Course Outcomes for Unit IV	**CO1, CO2, CO3, CO4,CO6**	
Unit V	**Game Designing: Tools and Techniques**	**(6hrs)**
Godot 3.2, Construct 2, Unity: Game Engine, LOVE 2D: Framework, GameMaker: Studio, Clickteam Fusion 2.5,GameFroot ,Sploder, Stencyl, Flowlab, GameSalad, Scratch,Instant Gamification Platforms: Mambo.io, Installation and use of BigDoor, ngageoint/gamification-server.		
Mapping of Course Outcomes for Unit V	**CO1, CO2, CO3, CO4, CO5,CO6**	
Unit VI	**Applications and Case Studies**	**(6 hrs)**
Applications:esports, Ads, healthcare, teaching-learning. **Case studies:**Counter-Strike, PUBG New State, Minecraft, Nike Plus: Making Fitness Fun,Yahoo! Gamifies Questions,Axie Infinity: blockchain-based game, An Interactive Museum Touch-Screen Game		
Mapping of Course Outcomes for Unit VI	**CO1, CO2, CO3, CO4, CO5,CO6**	

Textbooks:

1. Gabe Zechermann, Christopher Cunningham, Gamification by Design, Oreilly media, First, ISBN: 978-1-449-39767-8.
2. Mathias Fuchs, Sonia Fizek, Paolo Ruffino, NiklasSchrape, Rethinking Gamification
3. Katie SalenTekinbas , Eric Zimmerman, “Rules of PlayGame Design Fundamentals”, The MIT Press
4. Martin Osborne, An Introduction to Game Theory, Oxford University Press, 2003
5. http://meson.press/books/rethinking-gamification, Meson Press, First Edition,ISBN:978-3-95796-001-6.

Reference Books:

1. Susan Jacobs, Getting Gamification Right, The eLearning Guild, First.

E Books / E Learning References :

1) https://godotengine.org/, 2) https://mambo.io/, 3) https://unity.com/, 4) https://gamemaker.io/

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414452: ElectiveVI (Ethical Hacking and Security)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH): 03hrs/week	**03 Credits**	**Mid_Semester:30Marks** **End_Semester: 70 Marks**

Prerequisite Courses: Computer Network: OSI Model, TCP/IP Protocol Suite, Fundamentals of Cyber Security, Fundamentals of Windows, and Linux Operating System

Companion Course: Certified Ethical Hacking (EC Council), Ethical Hacking NPTEL

Course Objectives:

1. Understand Importance of Ethical Hacking and legalities of penetration Testing
2. Apply Foot printing techniques with realistic approach
3. Analyze Meta sploit tool with Kali Linux for penetration testing
4. Analyze Privilege Escalation techniques in Windows and Linux
5. Create awareness about web application security and Hacking
6. Apply WiFi Hacking and security Techniques

Course Outcomes:

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

CO1. Identify Ethical hacking processes and become acquainted with Penetration testing.
CO2. Recognize Foot printing techniques and apply in real time applications
CO3. Build knowledge about Meta sploit tool with Kali Linux
CO4. Differentiate Privilege Escalation in Windows and Linux
CO5. Construct Secure Web Applications to understand Hacking Techniques.
CO6. Recognize Wifi Hacking and Security techniques.

COURSE CONTENTS

Unit I	**Introduction to Basics of Ethical Hacking and Penetration Testing**	**(6 hrs)**
Introduction to basic Terminologies of Ethical Hacking, CIA(confidentiality, Integrity Availability , Types of Hackers , Ethical Hacking Process, Different tools for Ethical Hacking, Introduction to Kali Linux, What Is a Penetration Test, Vulnerability Assessments versus Penetration Test,Types of Penetration Testing:Network Penetration Test, Web Application Penetration Test,Mobile Application Penetration Test, Social Engineering Penetration Test, Physical Penetration Test		
Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**Foot printing & Port Scanning**	**(6 hrs)**
Foot printing: Introduction to foot printing, Understanding the information gathering methodology Introduction to fingerprinting in Ethical Hacking, Introduction to Reconnaissance, Reconnaissance types, Tools used for the reconnaissance phase, Port Scanning - Introduction, using port scanning tools, ping sweeps, Scripting, Enumeration-Introduction, Enumerating windows OS & Linux OS.		

Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**System Security and Hacking**	**(6hrs)**
Introduction to Metasploit ,Reconnaissance with Metasploit , Port Scanning with Metasploit , Compromising a Windows Host with Metasploit ,Client Side Exploitation Methods , E– Mails with Malicious Attachments ,Creating a Custom Executable , Creating a Backdoor with SET – PDF Hacking – Social Engineering Toolkit – Browser Exploitation – Post– Exploitation Introduction :Cracking Passwords – Password Cracking Websites – Password Guessing – Password Cracking Tools – Password Cracking Countermeasures – Escalating Privileges –Executing Applications – Keyloggers and Spyware		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Privilege Escalation in Windows and Linux**	**(6hrs)**
Introduction Windows Privileges, Horizontal vs. Vertical Privilege Escalation, Windows Privilege Escalation Techniques- Windows Authentication Bypass, Windows Privacy Policy Settings, Access Token Manipulation, DLL Search Order Hijacking, Privilege Escalation Attack Vectors- Credential Exploitation, Vulnerabilities and Exploits, Misconfigurations, Malware, Social Engineering. Linux Privilege Escalation- Introduction, Linux File Permission, Sudo Bypass, NFS, Passwords on Files, Kernel Exploits, LXD Linux Container.		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Web Application Hacking and Security**	**(6hrs)**
Introduction to Hacking Web Applications, Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), XML External Entity (XXE), Injections: SQL Injection& Code Injection, Denial of Service (DoS), Exploiting Third-Party Dependencies Web Application Security: Securing Modern Web Applications, Secure Application Architecture, OWASP Top 10 Web Application Security Risks and tools		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Wi-Fi Hacking and Security**	**(6 hrs)**
Wi-Fi Security: Introduction to Wireless Security, Working, Types of Security, Protocols- WEP, WPA, WPA2 cracking, Threats to Wi-Fi Security, Secure Home and Business Wi-Fi Network, Stronger Wi-Fi Security, Updating WiFi Security Settings for Home WiFi Networks. Wi-Fi Hacking: Essential Tools for Hacking Wireless Networks, Evil Twin attack, Network Sniffing and social engineering		
Mapping of Course Outcomes for Unit VI	**CO6**	

Textbooks:

1. Rafay Baloch, "Ethical Hacking and Penetration Testing Guide", CRC Press, 2014.
2. Andrew Hoffman, Web Application Security-Exploitation and Countermeasures for Modern Web Applications, O'Reilly publication
3. Marcus Pinto, DafyddStuttard, The Web Application Hacker's Handbook: Discovering and Exploiting Security Flaws, Wiley Publication
4. Alexis Ahmed, "Privilege Escalation Techniques, O'Reilly Media Company. Packt publishing. 2021

Reference Books:

1. Hacking: The Art of Exploitation by Jon Erickson
2. Basics of Hacking and Penetration testing: Made Easy by Patrick Engebreston
3. Penetration Testing: A Hands-on Introduction to Hacking by Georgia Weidman

E Books / E Learning References:

1. https://assets.ctfassets.net/kvf8rpi09wgk/5Yy2CMOxlE7eLlsTzFZ333/e656ff09a94ff0b63106de8d300903ac/CEH_Notes.pdf
2. https://resources.infosecinstitute.com/topic/process-scanning-and-enumeration/
3. https://owasp.org/Top10
4. https://medium.com/techloop/reconnaissance-the-key-to-ethical-hacking-3b853510d977
5. Don Matthews, Unintended Consequences, Ethical Hacking ...
6. www.coursera.org › lecture › industrial-iot-markets-security
7. https://www.coursera.org/lecture/cybersecurity-for-data-science/hacking-white-grey-and-black-hackers-DzVHT
8. https://www.coursera.org/lecture/cybersecurity-for-data-science/social-engineering-CD9QT
9. https://www.coursera.org/lecture/hacking-patching/penetration-testing-with-kali-linux-z06ZJ
10. https://medium.com/javarevisited/10-free-courses-to-learn-ethical-hacking-and-penetration-testing-for-beginners-84e40104aa6c.

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414452: Elective-VI (Augmented and Virtual Reality)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH): 03 hrs/week	**03 Credits**	**Mid_Semester :30 Marks** **End_Semester :70 Marks**
Prerequisite Courses, if any:		
Companion Course, if any:		

Course Objectives:

1. To study modern overviews on virtual reality and list the applications of VR.
2. To know the representation of Virtual world in VR.
3. To Study the fundamentals of visual perception, motion and tracking in real and virtual world.
4. To study modern overviews and perspectives on Augmented reality and list the applications of AR
5. To study the working of various state of the art AR devices.
6. To study computer vision concepts for AR and describe AR techniques.

Course Outcomes:

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

- **CO1.** Analyze how Virtual Reality systems work.
- **CO2.** Understand the representation of Virtual world.
- **CO3.** Describe the importance of motion and tracking in VR systems.
- **CO4.** Analyze how AR systems work and list the applications of AR.
- **CO5.** Identify the working of various AR components and AR devices.
- **CO6.** Make use of computer vision concepts for AR.

COURSE CONTENTS

Unit I	**Introduction to Virtual Reality**	**(6 hrs)**

Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.

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

Unit II	**Representing the Virtual World in VR**	**(6 hrs)**

Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR, Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations

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

Unit III	**Visual Perception, Motion and Tracking in VR**	**(6 hrs)**

Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models. Motion in Real and Virtual Worlds, Tracking- Tracking 2D & 3D Orientation.		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Introduction to Augmented Reality**	**(6 hrs)**
What Is Augmented Reality - Defining Augmented Reality, history of augmented reality, The Relationship Between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum Between Real and Virtual Worlds, Augmented Reality Concepts- How Does Augmented Reality Work? Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience, Applications of Augmented Reality		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Augmented Reality Components and Devices**	**(6 hrs)**
Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking &Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion. Types of AR devices.		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Computer Vision for Augmented Reality & AR Software**	**(6hrs)**
Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking Augmented Reality Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.		
Mapping of Course Outcomes for Unit VI	**CO6**	
Textbooks:		
1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016 **2.** Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002 **3.** Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016), ISBN-10: 9332578494		

Reference Books:
1. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009. 2. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003. 3. SanniSiltanen- Theory and applications of marker-based augmented reality. Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0
E Books / E Learning References:
1. http://lavalle.pl/vr/book.html 2. https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf 3. https://nptel.ac.in/courses/106/106/106106138/ 4. https://www.coursera.org/learn/ar

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414452: Elective VI (Business Analytics and Intelligence)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH): 03 hrs/week	**03 Credits**	**Mid_Semester: 30 Marks** **End_Semester: 70 Marks**
Prerequisite Courses: DBMS, ADBMS, DSBDA		
Companion Course: -		

Course Objectives:

1. Apply conceptual knowledge on how Business Intelligence is used within organizations.
2. Explore various systems and software for Business Intelligence
3. Understand several business scenarios where business analytics and intelligence can be useful
4. Understand the mathematical and analytical models behind Business Intelligence

Course Outcomes:

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

CO1. Apply conceptual knowledge on how Business Intelligence is used in decision making process
CO2. Use modelling concepts in Business Intelligence
CO3. Understand and apply the concepts of business reports and analytics with the help of visualization for business performance management
CO4. Comprehend the model-based decision making using prescriptive analytics
CO5. Analyze the role of analytics and intelligence in Business
CO6. Comprehend different Business Intelligence trends and its future impacts

COURSE CONTENTS

Unit I	**Introduction to Decision Making and Business Intelligence**	**(6hrs)**

Changing Business Environments, Decision Making & Simon's Decision-Making Process, Managerial roles in Decision Making, Information Systems Support for Decision Making, framework for Computerized Decision Support: The Gorry and Scott-Morton Classical Framework, Decision support systems (DSS). Capabilities of DSS, DSS Classification, DSS Components.

Business Intelligence (BI), Framework for BI, BI architecture, DSS - BI Connection, Goals of Business Intelligence, Business Intelligence: Tasks and Analysis Formats, BI use cases: Application in Patient Treatment, Application in Higher Education, Application in Logistics

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

Unit II	**Modeling in BI**	**(6hrs)**

Models and Modeling in BI, Model Presentation, Model Building, Model Assessment and Quality of Models, Modeling using Logical Structures: Ontologies &Frames, Modeling using Graph Structures: Business Process Model and Notation (BPMN) & Petri Nets, Modeling using Probabilistic Structures, Modeling Using Analytical Structures. Models and Data: Data Generation, The Role of Time, Data Quality

Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Business reporting, Visual analytics, and Performance management**	**(6 hrs)**
What Is a Business Report, Components of Business Reporting Systems, Data and Information Visualization, Types of Charts and Graphs, Visual Analytics, Performance Dashboards, Business Performance Management, Closed Loop BPM Cycle, Performance Measurement, Key Performance Indicators, Balanced Scorecards, The Four Perspectives of BSC? **BI Tools:** Tableau, Qlik, power BI, Dundas BI, Sisense, Webfocus, Oracle BI		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Prescriptive Analytics & Model-Based Decision Making**	**(6hrs)**
What are Descriptive analytics, predictive analytics, and prescriptive analytics, Decision Support Systems Modeling, Structure of Mathematical Models for Decision Support, Certainty, Uncertainty, and Risk, Decision Modeling with Spreadsheets, Mathematical Programming Optimization, Multiple Goals, Sensitivity Analysis, What-If Analysis, and Goal Seeking, Decision Analysis with Decision Tables and Decision Trees, Multi-criteria Decision Making with Pairwise Comparisons		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Role of Analytics and Intelligence inBusiness**	**(6 hrs)**
The role of visual and business analytics (BA) in BI and how various forms of BA are supported in practice. ERP and Business Intelligence, BI Applications in CRM, BI Applications in Marketing, BI Applications in Logistics and Production, Role of BI in Finance, BI Applications in Banking, BI Applications in Telecommunications, BI Applications in Fraud Detection, BI Applications in Retail Industry		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Business Analytics: Emerging Trends and Future Impacts**	**(6 hrs)**
Emerging Technologies, the critical success factors for implementing a BI strategy, Predicting the Future with the help of Data Analysis, BI Search & Text Analytics – Advanced Visualization – Rich Report, cloud computing and BI, Future beyond Technology. Impacts of Analytics in Organizations, Issues of Legality, Privacy, and Ethics, Location-Based Analytics for Organizations, Analytics Applications for Consumers.		
Mapping of Course Outcomes for Unit VI	**CO6**	
Textbooks:		
1. Wilfried Grossmann & Stefanie Rinderle-Ma “Fundamentals of Business Intelligence”, Springer, ISBN 978-3-662-46531-8 (eBook) **2.** 2. Business Intelligence and Analytics: Systems for Decision Support, 10th edition, ISBN 978-0-133-05090-5, by Ramesh Sharda, DursunDelen, and Efraim Turban, published by Pearson Education © 2014.		

Reference Books:

1. Sabherwal, R. and Becerra-Fernandez, I. (2011). Business Intelligence: Practices, Technologies, and Management. John Wiley.
2. Turban,E. and Volonino, L.(2011). Information Technology for Management: Improving Strategic and Operational Performance. 8th edn.Wiley.

E Books / E Learning References:

1. https://www2.deloitte.com/us/en/pages/deloitte-analytics/articles/business-analytics-case-studies.html
2. https://www.blastanalytics.com/analytics-case-studies
3. BI Foundations with SQL, ETL and Data Warehousing Specialization (Coursera)

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414452: Elective-VI (Blockchain Technology)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH): 3hrs/week	**03 Credits**	**Mid_Semester: 30 Marks** **End_Semester: 70 Marks**

Prerequisite Courses, if any:

Computer Network & security, distributed systems

Course Objectives:

1. To understand and explore cryptography in the blockchain.
2. To understand the working of blockchain technology.
3. To explore a blockchain platform: Ethereum and understand the concept of Tokenization
4. To understand the working of Hyper ledger.
5. To understand consensus mechanism.
6. To understand the applications & risks involved in blockchain.

Course Outcomes:

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

CO1. Understand the concept of cryptography and decentralization.
CO2. Acquire fundamental knowledge of blockchain with issues associated with it.
CO3. Acquire knowledge of Ethereum blockchain platform.
CO4. Understand hyper ledger fabric platform.
CO5. Acquire the knowledge regarding working of tokenization.
CO6. Describe the applications and risk involved

COURSE CONTENTS

Unit I	**Role of Cryptography in Blockchain**	**(6hrs)**

Introduction to cryptography, Use of Cryptography in Blockchain, Cryptographic algorithm, cryptographic elements, cryptocurrency and its Benefits, introduction to decentralized system Security, Integrity, and Privacy Issues of a Decentralized System.

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

Unit II	**Introduction to Blockchain Technology**	**(6 hrs)**

What is bitcoin, Mechanics of Bitcoin, bitcoin transaction, Introduction of Block chain, History of Blockchain, Block chain Technology Definition, Types of Block Chain, Peer to Peer Network, platform for decentralization, Transactional blocks, why use blockchain technology.

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

Unit III	**Blockchain Platforms: Ethereum**	**(6hrs)**

Blockchain Platform introduction, what is **Ethereum**, Ethereum feature,Components of Ethereum Ecosystem, Ethereum Programming Languages, Runtime Byte Code, Blocks and Blockchain, How Smart Contracts Work. **Introduction to Tokenization:** What is token, technology behind tokenization, how blockchain tokenization can help in enterprise systems, Tokenizing Shares and Fund Raising, challenges to tokenization		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Blockchain Platforms: Hyper ledger**	**(6 hrs)**
What is Hyper ledger, features of a Hyper ledger blockchain, How Does Hyper Ledger Fabric Work, The Architecture of Hyper ledger Fabric System, Benefits of Hyper ledger Fabric, Differences Between Ethereum And Hyper ledger		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Introduction to Tokenization**	**(6hrs)**
Introduction to Tokenization: What is token, technology behind tokenization, how blockchain tokenization can help in enterprise systems, Tokenizing Shares and Fund Raising, challenges to tokenization, Consensus Mechanism.		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Merits and Demerits of Blockchain and Applications**	**(6hrs)**
Selection Criteria for Blockchain platform for Applications, Blockchain and Enterprise – A Technology of Coordination, Risks and Limitations of Blockchain: Privacy, Security Risks of Blockchain, The "Evil Sides" of Blockchain and Legal Regulations for Blockchain: Ransomware, Money Laundering. Benefits of Blockchain in various scenarios. 1. Use Case: Blockchain for Supply Chain Financing 2. Use Case: Blockchain for Health Insurance.		
Mapping of Course Outcomes for Unit VI	**CO6**	

Textbooks:

1. Imran Bashir," Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks", Packt Publishing Limited, **ISBN-13:** 978-1787125445
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies", Princeton University Press, ISBN: hardcover9780691171692 ebook: 9781400884155

Reference Books:

1. Kumar Saurabh, Ashutosh Saxena, "Blockchain Technology: Concepts and Applications", Wiley publication, First Edition, ISBN: 978-8126557660.
2. Melanie Swan," Blockchain Blueprint for a New Economy", O'Reilly Media, Print ISBN: 9781491920497, 1491920491eText ISBN: 9781491920459, 1491920459

E Books / E Learning References:
1. BLOCKCHAIN, Cybrosys Limited Edition, E-book https://www.studocu.com/co/document/universidad-eia/calculo-integral/cybrosys-limited-edition-e-book-criptomonedas/14736261 2. Online Course by NPTEL https://nptel.ac.in/courses/106104220 https://drive.google.com/file/d/1PtYaDmWYaqPVGjKDnMYGWO5eoI5wMPtJ/view

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414453: Startup and Entrepreneurship		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Tutorial (TUT) : 03 hrs/week	**03 Credits**	**TW: 50 Marks**

Prerequisite Courses, if any:

Course Objectives:

1. To encourage students to build new technology, knowledge system based on innovations and can address local challenges.
2. Creating environment to innovate and build products towards sustainable development goals.
3. To provide platform for speedy communication and market reach of technology/ product developed by students.
4. To have start up ecosystem by bridging the gap between academia, industries and financial institutions, government support

Course Outcomes:

On Completion of Course students will be be able to:-

1. able to understand key concepts and framework of innovation and start-up ecosystem.
2. gain knowledge of how to develop start up ecosystem, its key components and how to influence and manage dynamics between them and increase the productivity of ecosystem.
3. understand the role of different stakeholders in ecosystem in building and supporting growth of start-ups.
4. have insight into global trend in start-up ecosystem and product development.
5. mapping different start-up ecosystems and developing performance indicators.

COURSE CONTENTS

Unit I	**Start-up Opportunity**	**(3 hrs)**
Identify business opportunity with problem identification, market size, existing pains for customers, existing alternatives, customer psychology, willingness to pay, customer segments.		
Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**Product/ Service Proposal**	**(3 hrs)**
Value Proposition Canvas, problem-solution fit, brainstorming, competition analysis, creating competitive advantage, sustainable differentiation.		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Business model**	**(3 hrs)**
Types, Lean canvas, Risky assumptions related to product, market, business, and execution capabilities		
Mapping of Course Outcomes for Unit III	**CO3**	

Unit IV	Minimum Viable Product (MVP)	(3 hrs)
Create and iterate, testing of MVP, customer feedback, validate risky assumptions, solution-market fit		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Financial Plan**	**(3 hrs)**
Manpower, Sales, Expenses, profitability projections, reality check, Funding plan, Pitch deck		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Marketing strategy**	**(3 hrs)**
Importance of brand and branding strategy, positioning, market penetration strategy/ plan, digital marketing, use of social media, customer acquisition Use of technology: for business scalability, effective execution, growth plan		
Mapping of Course Outcomes for Unit VI	**CO6**	

E Books / E Learning References:

- https://www.forbes.com/sites/palomacanterogomez/2019/04/10/how-to-frame-a-problem-to-find-the-right-solution/?sh=13af54355993
- https://hbswk.hbs.edu/item/how-entrepreneurs-can-find-the-right-problem-to-solve
- https://www.youtube.com/watch?v=6y3WIrgp_NY
- https://hbr.org/2014/07/what-you-need-to-know-about-segmentation
- https://www.youtube.com/watch?v=ReM1uqmVfP0
- https://www.youtube.com/watch?v=w62zW30PKms
- https://www.youtube.com/watch?v=FULiFueLGzE
- https://www.youtube.com/watch?v=7o8uYdUaFR4
- https://steveblank.com/2021/04/20/the-secret-to-the-minimum-viable-product/
- https://www.youtube.com/watch?v=1hHMwLxN6EM
- https://www.youtube.com/watch?v=4uGx14UVWPc
- https://www.youtube.com/watch?v=OVnN4S52F3k
- https://www.entrepreneur.com/article/251687
- https://www.forbes.com/sites/forbesbusinessdevelopmentcouncil/2020/09/14/13-key-steps-to-developing-a-go-to-market-strategy/?sh=53023c476fc1
- https://www.garyfox.co/business-model/business-model-channels/
- https://www.forbes.com/sites/allbusiness/2019/05/25/small-business-website-tips/?sh=2c551a0421ad

- https://www.forbes.com/sites/forbesagencycouncil/2020/10/08/digital-marketing-best-practices-for-startups/?sh=2e55af9e3ded

Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
414454: Lab Practice - V

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical (PR): 4 hrs/week	02 Credits	PR: 25 Marks TW: 50 Marks

Prerequisites:

1. Operating Systems
2. Computer Network Technology
3. Web Application Development

Course Objectives:

1. The course aims to provide an understanding of the principles on which the distributed systems are based, their architecture, algorithms and how they meet the demands of Distributed applications.
2. The course covers the building blocks for a study related to the design and the implementation of distributed systems and applications.

Course Outcomes:

Upon successful completion of this course student will be able to:

1. Demonstrate knowledge of the core concepts and techniques in distributed systems.
2. Learn how to apply principles of state-of-the-Art Distributed systems in practical application.
3. Design, build and test application programs on distributed systems

Guidelines for Instructor's Manual

The faculty member should prepare the laboratory manual for all the experiments, and it should be made available to students and laboratory instructor/Assistant.
The instructor's manual should include prologue, university syllabus, conduction & Assessment guidelines, topics under consideration-concept, objectives, outcomes, algorithm written in pseudo language, sample test cases and references.

Guidelines for Student's Lab Journal

1. The laboratory assignments are to be submitted by students in the form of journals. The Journal consists of prologue, Certificate, table of contents, and handwritten/printed write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, Software & Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory-Concept, algorithms, printouts of the code written using coding standards, sample test cases etc.)
2. Practical Examination will be based on the term work.
3. Candidate is expected to know the theory involved in the experiment.
4. The practical examination should be conducted if the journal of the candidate is completed in all respects and certified by concerned faculty and head of the department.

Guidelines for Lab /TW Assessment

Examiners will assess the term work based on performance of students considering the parameters such as timely conduction of practical assignment, methodology adopted for implementation of practical assignment, timely submission of assignment in the form of handwritten/printed write-up along with results of implemented assignment, attendance etc.
Examiners will judge the understanding of the practical performed in the examination by asking some

questions related to theory & implementation of experiments he/she has carried out.

Guidelines for Laboratory Conduction

Staff in-charge will suitably frame the assignments and flexibility may be incorporated. All the assignments should be conducted on the latest version of Open-Source Operating Systems, tools and Multi-core CPU supporting Virtualization and Multi-Threading.

Guidelines for Practical Examination

Both internal and external examiners should jointly set problem statements for practical examination. 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 judge the student 's understanding of the fundamentals, effective and efficient implementation. The evaluation should be done by both external and internal examiners.

List of Laboratory Assignments

1. Implement multi-threaded client/server Process communication using RMI.
2. Develop any distributed application using CORBA to demonstrate object brokering. (Calculator or String operations).
3. Develop a distributed system, to find sum of N elements in an array by distributing N/n elements to n number of processors MPI or OpenMP. Demonstrate by displaying the intermediate sums calculated at different processors.
4. Implement Berkeley algorithm for clock synchronization.
5. Implement token ring based mutual exclusion algorithm.
6. Implement Bully and Ring algorithm for leader election.
7. Create a simple web service and write any distributed application to consume the web service.
8. **Mini Project (In group):** A Distributed Application for Interactive Multiplayer Games

Reference Books:

1. Distributed Systems –Concept and Design, George Coulouris, Jean Dollimore, Tim Kindberg& Gordon Blair,Pearson,5th Edition,ISBN:978-13-214301-1.
2. Distributed Algorithms,Nancy Ann Lynch, Morgan Kaufmann Publishers, illustrated, reprint, ISBN: 9781558603486.
3. Java Network Programming & Distributed Computing by David Reilly, Michael Reilly
4. Distributed Systems - An Algorithmic approach by Sukumar Ghosh (good book for distributed algorithms)
5. Distributed Algorithms: Principles, Algorithms, and Systems by A. D. Kshemkalyani and M. Singhal (Good for algorithms, but very detailed, has lots of algorithms; good reference)
6. Design and Analysis of Distributed Algorithms by Nicola Santoro (good, distributed algorithms book)

Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
414455: Lab Practice VI (Ethical Hacking and Security)

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical (PR): 02hrs/week	01 Credits	OR: 50 Marks TW: 25 Marks

Prerequisites: Computer Network, Cyber Security, Kali Linux

Course Objectives:

1. To obtain practical knowledge of finding vulnerabilities in network and web applications.
2. To understand legal usage of industry standard security tools in an isolated environment.
3. To gain hands-on practical on current security threats and its approach.
4. To grasp the understanding of breaching different operating systems.

Course Outcomes:

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

CO1. Perform internal and external vulnerability analysis on web application and network.
CO2. Comprehend the hacker's mindset while conducting reconnaissance and system hacking.
CO3. Implement industry standard security protocols to prevent cyber-attacks.
CO4. Carry-out the same tactics, techniques, and procedures as actual hackers.

Guidelines for Instructor's Manual

1. The faculty member should prepare the laboratory manual for all the experiments, and it should be made available to students and laboratory instructor/Assistant.

Guidelines for Student's Lab Journal

1. Student should submit term work in the form of handwritten journal based on specified list of assignments.
2. Practical Examination will be based on the term work.
3. Candidate is expected to know the theory involved in the experiment.
4. The practical examination should be conducted if and only if the journal of the candidate is complete in all aspects.

Guidelines for Lab /TW Assessment

1. Examiners will assess the term work based on performance of students considering the parameters such as timely conduction of practical assignment, methodology adopted for implementation of practical assignment, timely submission of assignment in the form of handwritten write-up along with results of implemented assignment, attendance etc.
2. Examiners will judge the understanding of the practical performed in the examination by asking some questions related to the theory & implementation of the experiments he/she has carried out.
3. Appropriate knowledge of usage of software and hardware related to respective laboratory should be checked by the concerned faculty member.

Guidelines for Laboratory Conduction

1. There must be hand-written write-ups for every assignment in the journal. Student should work on real time ethical hacking tools and find vulnerabilities, Kali linux software must be installed on system with different commands.

Guidelines for Practical Examination

Practical should be conducted on Kali Linux.

Google dorking should be experienced with real time website finding vulnerabilities.

List of Laboratory Assignments

1. **Assignment No 1: Reconnaissance (2 Hrs)**
   To perform reconnaissance on a website using google dorking technique on a tryhackme room.
   Perform Google Dorking: https://tryhackme.com/room/googledorking
2. **Assignment No.2(2 Hrs)**
   To perform reconnaissance on a website using web OSINT technique on a tryhackme room.
   Perform Web OSINT: https://tryhackme.com/room/webosint
3. **Assignment No 3: Scanning, enumeration, and analysis (2 Hrs)**
   To perform scanning using nmap(a powerful network scanning tool) in a tryhackme room.
   Perform scanning using Nmap tools: https://tryhackme.com/room/furthernmap
   Perform vulnerability analysis using Nessus tool:
   https://tryhackme.com/room/rpnessusredux
4. **Assignment 4 - POST-EXPLOITATION (2Hrs)**
   Perform Windows Privilege Escalation:
   https://tryhackme.com/room/windowsprivescarena
   Perform Post-Exploitation: https://tryhackme.com/room/postexploit
   Perform Linux Privilege Escalation: https://tryhackme.com/room/linuxprivesc

Reference Books:

1. Hacking: The Art of Exploitation, 2nd Edition 2nd Edition, Kindle Editionby Jon Erickson
2. javascript:void(0)The Basics of Hacking and Penetration Testing, Patrick Engebretson, 2nd edition
3. he Hacker Playbook 2, Peter Kim, 1st edition
4. Penetration Testing, Georgia Weidman, 1st edition

Virtual Laboratory

Penetration Testing Lab | Virtual Hacking Labs
Kali Linux | Penetration Testing and Ethical Hacking Linux ...
https://www.kali.org

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414455: Lab Practice VI (Augmented and Virtual Reality)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical (PR):2 hrs/week	**01 Credit**	**OR: 50 Marks** **TW: 25 Marks**
Prerequisites:		
Course Objectives:		
Course Outcomes:		

Guidelines for Instructor's Manual

1. The faculty member should prepare the laboratory manual for all the experiments, and it should be made available to students and laboratory instructor/Assistant.

Guidelines for Student's Lab Journal

1. Student should submit term work in the form of handwritten journal based on specified list of assignments.
2. Practical Examination will be based on the term work.
3. Candidate is expected to know the theory involved in the experiment.
4. The practical examination should be conducted if and only if the journal of the candidate is complete in all aspects.

Guidelines for Lab /TW Assessment

1. Examiners will assess the term work based on performance of students considering the parameters such as timely conduction of practical assignment, methodology adopted for implementation of practical assignment, timely submission of assignment in the form of handwritten write-up along with results of implemented assignment, attendance etc.
2. Examiners will judge the understanding of the practical performed in the examination by asking some questions related to the theory & implementation of the experiments he/she has carried out.
3. Appropriate knowledge of usage of software and hardware related to respective laboratory should be checked by the concerned faculty member.

Guidelines for Laboratory Conduction

1. There must be hand-written write-ups for every assignment in the journal.
2. Appropriate tools must be made available to students to perform assignments. Prefer open source if available.

Guidelines for Practical Examination

The exam will be based on all assignments .

List of Laboratory Assignments

1. **Assignment No.1**
   Study of various AR VR Development tools.
2. **Assignment No.2**
   Case study of an any single application using both VR and AR technologies.
3. **Assignment No.3**
   Installation and understanding of UNITY 3D IDE.
4. **Assignment No.4**

Create a C# script which plays a video when an image is scanned using AR App (use ARCore& Unity).

Text Books

1. Steve Aukstakalnis- Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Addison-Wesley Professional, September 2016, ISBN: 9780134094328
2. Allan Fowler- Beginning iOS AR Game Development Developing Augmented Reality Apps with Unity and C#, 1st Edition, Apress Publications, 2018, ISBN 978-1484236178

Reference Books

1. Learning C# by Developing Games with Unity 3D Beginner's Guide Terry Norton Pack Publication Packt publishing, 9th October 2017. ISBN-13: 978-1787286436
2. Jonathan Linowes, KrystianBabilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia.

Online links

Manual:https://docs.unity3d.com/Packages/com.unity.xr.arfoundation@4.1/manual/index.html

Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
414455: Lab Practice VI (Business Analytics and Intelligence)

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical (PR): 02hrs/week	01 Credits	OR: 50 Marks TW: 25 Marks

Prerequisites: DSBDA Lab

Course Objectives:

1. To apply conceptual knowledge on various Business Analytics aspects.
2. To explore various tools for Data Analysis and visualization
3. To understand different practical techniques used by businesses for analytics
4. To understand the mathematical and analytical models behind Business Intelligence

Course Outcomes:

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

CO1. Compare and analyze different analytical tools used by businesses

CO2. Understand the application of critical notion of KPI using real time case studies

CO3. Design and implement the analytical models using suitable tools

CO4. Create visualizations using suitable tools

Guidelines for Instructor's Manual

Lab Assignments: Following is a list of suggested laboratory assignments for reference. Laboratory Instructors may design a suitable set of assignments for their respective courses at their level. For each laboratory assignment, it is essential for students to draw/write/generate visualizations, mathematical model, Test data set and comparative/complexity analysis (as applicable).

Guidelines for Student's Lab Journal

Program codes / analysis with sample output of all performed assignments are to be submitted as softcopy. Use of Google Classroom / Drive /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 in the Laboratory. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journals may be avoided. Submission of journal/ term work in the form of softcopy is desirable and appreciated.

Guidelines for Lab /TW Assessment

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

Guidelines for Laboratory Conduction

Following is a list of suggested laboratory assignments for reference. Laboratory Instructors may design a suitable set of assignments for respective courses at their level. Beyond curriculum assignments and mini-project may be included as a part of laboratory work. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. The Inclusion of few optional assignments that are intricate and/or beyond the scope of curriculum will surely be the value addition for the students and it will satisfy the intellectuals within the group of the learners and will add to the perspective of the learners. For each laboratory assignment, it is essential for students to draw/write/generate visualizations, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorials may be as per guidelines of authority

Guidelines for Practical Examination

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

List of Laboratory Assignments

Group A

1. Comparative Study of Open-Source Data Analysis tools
2. Identify Key Performance Indicators (KPI) for any real time case study and present analysis for the same

Group B

1. Create, model, and analyze Petri nets with a standards-compliant Petri net tool for Producer / Consumer OR Dining Philosophers problem
2. Perform a what-if-analysis on Book Store Scenario using Excel
3. Create a decision tree for predicting the loan eligibility process using Python

Group C

1. Create following visualizations using Excel
   a. Combo charts
   b. Band Chart
   c. Thermometer Chart
   d. Gantt Chart
   e. Waterfall Chart
   f. Sparklines
   g. PivotCharts
2. Create interactive visualizations using any open-source tool. (Eg. KNIME, D3.js, Grafana, etc.)
3. Create a dashboard / report using Google Data Studio on YouTube Channel Data / Google Ads Data / Search Console Data

Reference Books:

1. Wilfried Grossmann & Stefanie Rinderle-Ma "Fundamentals of Business Intelligence", Springer, ISBN 978-3-662-46531-8 (eBook)
2. https://datastudio.google.com/
3. http://pipe2.sourceforge.net/
4. https://www.knime.com/

Savitribai Phule Pune University, Pune

Final Year Information Technology (2019 Course)

414455: Lab Practice VI (Blockchain Technology)

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical (PR): 02 hrs/week	01 credit	OR: 50 Marks TW: 25 Marks

Prerequisites: Programming skills: javascript, react.js

Course Objectives:

1. To acquaint students with the basic skills required for adopting to crypto currency & block chain
2. To acquire knowledge about consensus algorithms and its working.

Course Outcomes:

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

1.To implement small blockchain experimentations.

2. Identify Consensus mechanism for Blockchain Application.

Guidelines for Instructor's Manual

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

Guidelines for Student's Lab Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment.

Guidelines for Lab /TW Assessment

Faculty member should frame Practical Assignments based on given list of assignments. Students will submit term work in the form of journal containing handwritten write-ups/ source code and output. Staff incharge should maintain a record of continuous assessment and produced at the time of examination

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. Use of open-source software is to be encouraged. All the assignments should be conducted on Latest version of open-Source Operating Systems, tools and Multi-core CPU supporting Virtualization and Multi-Threading.

Guidelines for Practical Examination

Both internal and external examiners should jointly set problem statements. During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement.

List of Laboratory Assignments

1. **Assignment No.1**

   To setup a crypto wallet

   a) i) hosted wallets ii) self-custody wallet iii) hardware wallets (optional) and evaluate each of these.

b) Understand the basic operations in the wallet on bitcoin such as 1) buy 2) sell 3) send 4) receive 5) exchange 6) mining.

2. **Assignment No.2**
   1) Create a local Ethereum network using Hardhat or any other tool, build a smart contract that lets you send a 👋 (wave) to your contract and keep track of the total # of waves. Compile it to run locally.
   2) Connect to any Ethereum walleteg.Metamask. Deploy the contract with testnet. Connect wallet with your webapp. Call the deployed contract through your web app. Then store the wave messages from users in arrays using structs
3. **Assignment no.3**
   Prepare your build system and Building Bitcoin Core.
   a. Write Hello World smart contract in a higher programming language (Solidity).
   b. Solidity example using arrays and functions
4. **Assignment no.4**
   Deploy a simple contract to the Ethereum blockchain.
5. **Assignment no.5**
   Polling / voting system using Solidity, Ethereum and a data structure hashmap(optional)

Online References

- https://buildspace.so/p/build-solidity-web3-app/lessons/welcome
- https://www.theinsaneapp.com/2022/05/best-web3-projects.html
- https://www.coinbase.com/learn/tips-and-tutorials/how-to-set-up-a-crypto-wallet

Savitribai Phule Pune University, Pune Final Year Information Technology (2019 Course) 414456 : Project-II		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical: 10 hrs/week	**05 Credits**	**Term Work : 100 Marks** **Oral : 50 Marks**
Prerequisite Courses, if any: Project Phase-I (B.E. (IT) Final Year Semester-I)		
Companion Course, if any: NA		

Course Objectives:

1. To enable the student to extend further the investigative study taken up under Project stage-I, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory / Industry.
2. To build up exposure of implementation and hence develops analysis of results by considering performance measures.
3. To expose students to product development environment using industrial experience, use of state of art technologies.
4. To encourage and expose students with funding agency for sponsored projects.
5. To generate the opportunities to experience practically the facts learned in various fields together.
6. To improve overall communication skill, Teamwork and Leadership Qualities, professionalism.
7. Evaluate the various validation and verification methods.
8. Analyzing professional issues, including ethical, legal and security issues, related to computing projects.
9. To evaluate alternative approaches, and justify the results obtained.

Course Outcomes:

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

1. To apply engineering and mathematical knowledge to investigate / select proper technology / Algorithm suitable to solve the problem in hand.
2. To apply knowledge of statistics for analysis of results and express conclusion and justification for the same.
3. To design and conduct experiments, as well as to analyze and interpret data or develop prototype model of the application.
4. To communicate effectively.
5. Get broad education which is necessary to understand the impact of engineering solutions in a global, economic, environmental, ethically and societal context.
6. Recognition of the need for, and an ability to engage in life-long learning.

Introductory Information:

BE Project Phase-II is the continuation of Project Phase-I for implementation, and analysis of results to arrive a valid conclusion with justification.

Guidelines to Faculty and Students:

1. Preferably same review committee needs to continue for Project Phase-II.
2. There shall be **TWO** reviews in Project phase –II (in semester-II) by the review committee.
3. The Project Review committee will be responsible for evaluating the timely progress of the projects. It is suggested to evaluate the skills learned by the students in their PBL (in their previous years).
4. Student needs to justify the Algorithm / Model used for implementation.
5. Every student of the project group shall make presentation on the progress made by them before the committee during each reviews. Each student/group is required to give presentation as part of review for 10 to 15 minutes followed by a detailed discussion and query session.
6. Students need to note down the queries raised during review(s) and comply the same in the next review session.
7. The record of the remarks/suggestions of the review committee (project dairy) should be properly maintained in continuation of Project Phase-II and should be made available at the time of university examination.
8. Project group needs to present / publish **TWO** papers (One in each semester, at least one paper should be in **UGC – Care journal**).
    a. Paper must be checked for Plagiarism by any open software.
    b. One paper during second semester which includes Methodologies / Algorithms implemented, Results obtained, Analysis of results and conclusion.
9. Project report must also be checked for Plagiarism.
10. 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.

Review 3: Implementation –

Points to be covered:

1. Detailed study of Algorithm(s) / Model / Hardware specification (As applicable).
2. Confirmation of Data set used (As applicable)
3. Detailed ER Diagram / DFD diagrams.
4. Detailed UML Diagrams.
5. Sample results (module based).

Review 4: Testing and Result Analysis.

Points to be covered:

1. Appropriate test cases and results of test cases.
2. Representation of results with analysis.
3. Conclusion over performance parameters (as applicable)
4. Conclusion and future work suggested.
5. Knowledge of references utilized.

Evaluation Criteria:

Following criteria and weightage is suggested for evaluation of Project-Phase II Term Work.

1. Availability of standard Data set / Input parameters: 10%
2. Depth of Understanding of implemented Technology / Algorithm / Domain / Model: 40%
3. Test cases / Validation and Verification process: 10%
4. Justification of Algorithm / Model / Architecture / System: 10%
5. Analysis of results and conclusion: 10%
6. Presentation Skill: 10%
7. Report preparation and Paper publication: 10%

Project report contains the details as Follows:

It is suggested to have only one Project report which includes work carried at Project Phase-I as well.
Project report must have:

- **i.** Certificate from the institute.
- **ii.** Certificate sponsoring organization (If any).
- **iii.** Acknowledgement.
- **iv.** Abstract.
- **v.** Contents.
- **vi.** List of Abbreviations (As applicable).
- **vii.** List of Figures (As applicable).
- **viii.** List of Graphs (As applicable).
- **ix.** List of Tables (As applicable).
  - **1)** Introduction and aims/motivation and objectives.
  - **2)** Literature Survey (with proper citation).
  - **3)** Problem Statement/definition.
  - **4)** Software Requirement Specification (In SRS Documentation only).
  - **5)** Flowchart
  - **6)** Project Requirement specification.
  - **7)** Proposed system Architecture.
  - **8)** High level design of the project (DFD , UML , ER Diagrams).
  - **9)** System implementation-code documentation: Algorithm style, Description of detailed methodologies, protocols used etc..as applicable.
  - **10)** Test cases.
  - **11)** GUI/Working modules and Experimental Results in suitable format.
  - **12)** Project Plan.
  - **13)** Analysis and Conclusions with future work.
  - **14)** Bibliography in IEEE format.

Appendices

- **a)** Plagiarism Report of Paper and Project report from any open source tool.
- **b)** Base Paper(s) [If any].
- **c)** Tools used / Hardware Components specifications [If any].
- **d)** Published Papers and Certificates (Both Papers).

Use appropriate plagiarism tools, reference managers, Latex for efficient and effective project writing.

Savitribai Phule Pune University, Pune B.E Information Technology (2019 Course) 414457A: Audit Course8 Functional Programming in Haskell		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH): 01 hrs/week	**Non-Credit**	**Audit Course**

Prerequisite Courses: Programming using any high-level language.

Course Objectives:

1. To understand the paradigm of programming.
2. To develop insight about 'lazy' execution.
3. To learn the syntax and semantics of the Haskell programming language.
4. To learn 'idioms' of Haskell programming

Course Outcomes:

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

- **CO1.** Understand the correctness of programs.
- **CO2.** Make use of higher-order functions.
- **CO3.** Make use of the data encapsulation and parametric polymorphism for functional programming.
- **CO4.** Understand the importance of the 'type checking' of values/functions to develop programs relatively faster.

COURSE CONTENTS

Unit I	**Introduction**	**(3 hrs)**
Types and Values, Running Haskell Programs, Lists, Strings, Tuples. Introduction to ghci interpreter		
Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**Functions**	**(3 hrs)**
Functions, Type Inference, Recursion, Higher-order Functions, Polymorphic Types, Lambda Functions. Computation as rewriting, lazy evaluation and infinite data structures		
Mapping of Course Outcomes for Unit II	**CO2, CO3**	
Unit III	**Data Types**	**(3 hrs)**
User defined Data Types, Abstract data types, Recursive Data Types-Binary search trees		
Mapping of Course Outcomes for Unit III	**CO4**	
Unit IV	**Arrays and IO**	**(3hrs)**
Arrays, Input / Output		
Mapping of Course Outcomes for Unit IV	**CO4**	

Textbooks:
1. Brian O'Sullivan, John Goerzen and Don Stewart, 'Real World Haskell', O'reilly. **2.** MiranLipovača, 'Learn You a Haskell for Great Good!', No Starch Press. **3.** Graham Hutton, "Programming in Haskell", Cambridge University Press. **4.** https://nptel.ac.in/courses/106106137
Evaluation
Students should select any one of the topic in a group of 3 to 5. Students should submit a written report and make a presentation on the topic. The task should not be repeated among students. Report will be evaluated by the faculty as per rubrics defined by him/her/them at start of course.

Savitribai Phule Pune University, Pune

B.E Information Technology (2019 Course)

414457B: Audit Course 8

Cyber Laws And Use Of Social Media

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory (TH): 01 hrs/week	Non-Credit	Audit Course

Prerequisite Courses: Programming using any high-level language.

Course Objectives:

To understand and aware Cyber laws which are focusing on protecting the privacy of users from organizations and other users.

To know the cyber threats happening around them and to help them stay secure in the daily use of Cyberspace.

Course Outcomes:

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

CO1. Understand the importance of IT Act.

CO2. Understand the significance of cyber laws and its practices.

CO3. Identify and Analyze software vulnerabilities and security solutions to reduce the risk of exploitation.

CO4. To study various privacy and security concerns of Online social media.

COURSE CONTENTS

Unit I	Introduction to IT Act	(03 hrs)
Evolution of the IT Act, Genesis and Necessity Various authorities under IT Act and their powers: Penalties & Offences, amendments. Traditional Principals of Jurisdiction, Extra-terrestrial Jurisdiction, Case Laws on Cyber Space Jurisdiction		
Mapping of Course Outcomes for Unit I	**CO1**	

Unit II	Cyber Law: International Perspective	(03 hrs)
EDI: Concept and legal Issues, UNCITRAL Model Law, Electronic Signature Laws of Major Countries, Cryptography Laws, Cyber Laws of Major Countries, EU Convention on Cyber Crime		
Mapping of Course Outcomes for Unit II	**CO2**	

Unit III	Cyber Forensic and Computer Crimes	(03 hrs)
Types, Crimes targeting Computers: Definition of Cyber Crime & Computer related crimes. Classification & Differentiation between traditional crime and cyber-crimes. Cyber-crimes and cyber terrorism: - a) Cyber-crimes and the categories of crime i) Cyber frauds ii) Cyber thefts iii) Cyber stacking b) Cyber Terrorism. c) Hacking, Virus, Trojan, worms etc.		
Mapping of Course Outcomes for Unit III	**CO3**	

Unit IV	Use of Social Media	(03 hrs)

Elements of Social Networks, Social Media Outlets. (Facebook, Twitter, etc.): How the differences impact, how to use them. Videos: Broadcasting to peers, many to many, friends and followers, apps, pages, pseudonyms of good and evil Focused Networks (Flickr, Linked In, YouTube, etc.) networks that focus on specific topics or activities	
Mapping of Course Outcomes for Unit IV	**CO4**
Textbooks:	
1. The Information Technology act, 2000, Bare Act-Professional Book Publishers, New Delhi. **2.** Aparna Viswanathan, "Cyber Law- Indian and International Perspectives On Key Topics Including Data Security, E-Commerce, Cloud Computing and Cyber Crimes". **3.** First Responder's Guide to Computer Forensics by Richard Nolan etal; Carnegi Mellon, 2005. **4.** https://nptel.ac.in/courses/106106146	
Evaluation	
Students should select any one of the topics in a group of 3 to 5. Students should submit a written report and make a presentation on the topic. The task should not be repeated among students. Report will be evaluated by the faculty as per rubrics defined by him/her/them at start of course.	

Savitribai Phule Pune University, Pune

B.E Information Technology (2019 Course)

414457C: Audit Course 8

Constitution Of India

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory(TH): 01 hrs/week	Non-Credit	Audit Course

Prerequisite Courses, if any:

Course Objectives:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights.
3. To address the role and functions of local administration.

Course Outcomes:

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

CO1. Understand the Principles of the Indian Constitution.

CO2. Understand and identify the growth of the demand for civil rights in India.

CO3. Understand the organizations of governance.

CO4. Understand the role and functions of local administration.

COURSE CONTENTS

Unit I	History of Making of the Indian Constitution	(03 hrs)
History Drafting Committee, (Composition & Working), Philosophy of the Indian Constitution: Preamble, Salient Features		
Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**Contours of Constitutional Rights & Duties**	**(03 hrs)**
Fundamental Rights, Right to Equality, Right to Freedom, right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Organs of Governance:**	**(03 hrs)**
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Local Administration and Election Commission**	**(03 hrs)**

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected representative, CEO of Municipal Corporation.
Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role.
Block level: Organizational Hierarchy (Different departments),
Village level: Role of Elected and Appointed officials, Importance of grass root democracy.
Election Commission: Role and Functioning

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

Textbooks:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.
5. https://nptel.ac.in/courses/129106003

Evaluation:

Students should select any one of the topics in a group of 3 to 5. Students should submit a written Report. Make a presentation on the topic. Report will be evaluated by the faculty as per rubrics defined by them at start of course.