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

Curriculum for
Final Year of
BE (Artificial Intelligence & Machine Learning)

(2020 Course)
(With effect from AY 2023-24)

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Savitribai Phule Pune University, Pune Bachelor of Engineering (Artificial Intelligence & Machine Learning)	
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 AI & ML for analyzing, designing and implementing complex engineering problemsof any domain with innovative approaches.**
PEO3	**Possess an attitude and aptitude for research, entrepreneurship and higher studies inthe field of Computer Science and Information Technology.**
PEO4	**Have commitment t o ethical practices, societal contributions through communities andlife-long learning.**
PEO5	**Possess better communication, presentation, time management and teamwork skills leading to responsible & competent professional and will be able to address challenges inthe field of AI & ML at the 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, modern engineering technology tools, and standard processes necessary for practice as an IT professional.
PO6	The Engineer and Society	An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modelling and design of computer-based systems with necessary constraints and assumptions.
PO7	Environment and Sustainability	An ability to analyze and provide solutions for the local and global impactof 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, professional courses and extracurricular activities.
PO11	Project Management and Finance	An ability to communicate effectively in the 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 Artificial Intelligence & Machine Learning Program will demonstrate	
PSO1	An ability to apply the theoretical concepts and practical knowledge of Artificial Intelligence & Machine Learning 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. AI & ML graduates should be able towork 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.

Savitribai Phule Pune University

Final Year of Artificial Intelligence and Machine Learning (2020 Course)

(With effect from Academic Year 2023-24)

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
418541	Information Retrieval in AI	03	-	-	30	70	-	-	-	100	3	-	-	3
418542	Cloud Computing	03	-	-	30	70	-	-	-	100	3	-	-	3
418543	Deep Learning for AI	03	-	-	30	70	-	-	-	100	3	-	-	3
418544	Elective III	03	-	-	30	70	-	-	-	100	3	-	-	3
418545	Elective IV	03	-	-	30	70	-	-	-	100	3	-	-	3
418546	Lab Practice III	-	04	-	-	-	25	-	25	50	-	2	-	2
418547	Lab Practice IV	-	02	-	-	-	25	25	-	50	-	1	-	1
418548	Project Stage I	-	-	02	-	-	50	-	-	50	-	-	2	2
418549	Audit Course 7													
										Total Credit	15	03	02	20
	Total	15	06	02	150	350	100	25	25	650	15	03	02	20

Elective III:

- Quantum Computing
- Block Chain
- AI in Drones

Elective IV:

- Ethical Hacking and cyber forensics
- Augmented Reality and Virtual Reality
- DevOps in Machine Learning

Lab Practice-III:

It is based on subjects:

- Information Retrieval in AI

Lab Practice-IV:

It is based on subjects:

- Deep Learning for AI

Audit Courses 7:

- 418549A: Copyrights and Patents
- 418549B: Stress Management by Yoga
- 418549C: English for Research Paper Writing

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Final Year of Artificial Intelligence and Machine Learning (2020 Course)

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Semester VIII

Course Code	Course Name	Teaching Scheme (Hours/week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	Mid-Sem	End-Sem	Term work	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
418550	Natural Language Processing	03	-	-	30	70	-	-	-	100	03			03
418551	Elective V	03	-	-	30	70	-	-	-	100	03			03
418552	Elective VI	03	-	-	30	70	-	-	-	100	03			03
418553	Startup and Entrepreneurship	-	-	03	-	-	50	-	-	50	-	-	03	03
418554	Lab Practice V	-	04	-	-	-	50	25	-	75		02		02
418555	Lab Practice VI	-	02	-	-	-	25	-	50	75		01		01
418556	Project Stage II	-	10	-	-	-	100	-	50	150		05		05
418557	Audit Course 8													
										Total Credit	09	08	03	20
	Total	09	16	03	90	210	225	25	100	650	09	08	03	20

Elective V:

- Distributed System
- Software Project and Management
- Computer Vision

Elective VI:

- Reinforcement Learning
- Big data analytics
- AI using R programming

Lab Practice V:

It is based on subjects:

- Natural Language Processing

Lab Practice VI:

It is based on subjects:

- Elective VI

Audit Courses 8:

- 418557A: Functional Programming in Haskell
- 418557B: Cyber Laws and Use of Social Media
- 418557C: Constitution of India

SEMESTER – VII

Savitribai Phule Pune University, Pune

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418541: Information Retrieval in AI

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

Prerequisite Courses: Data Structures and Files, Database management systems.

Companion Course, if any: Lab Practice III

Course Objectives:

1. To understand the concepts of information retrieval.
2. To comprehend 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 apprehend information sharing on the web.
6. To cognize 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 the 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

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.

AUTOMATIC CLASSIFICATION: Measures of association, The cluster hypothesis, Single-link, The appropriateness of stratified hierarchic cluster methods.

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, TF-IDF (Term Frequency/Inverse Document Frequency) Weighting, Latent Semantic Indexing 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, Averaging techniques, Interpolation, Composite measures, MRR, F-Score, NDCG, user-oriented measures, The Swets model. **Visualization in Information System:** Starting points, Query Specification, document context, User relevance judgment, Interface support for seethe arch 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 Modelling, Query Language, Background-Spatial Access Method, A Generic Multimedia Indexing Approach, One-Dimensional Time Series, Two-Dimensional color Images, Automatic Feature Extraction, Trends and Research Issue.		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Advanced Information Retrieval**	**(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.		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Information Retrieval in AI**	**(06 hrs)**
Metasearch: Introduction to Metasearch, Need and Significance of Metasearch, Difefrence between simple search and Metasearch, basics working of metasearch, Real Life Examples of metasearch engines		
Mapping of Course Outcomes for Unit VI	**CO6**	

Text Books:

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. Chabane DjerO'Reillytimedia mining: A highway to intelligent multimedia documents, Kulwer Academic Publisher, ISBN: 1-4020-7247-3.
1. V. S. Subrahamanian, Satish K. Tripathi, Multimedia information System, Kulwer Academic Publisher. Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze, An Introduction to Information Retrieval, Cambridge University Press, 2008.
2. Marek Kowalkiewicz, Maria E. Orlowska, Tomasz Kaczmarek, Witold Abramowicz, Web Information Extraction and Integration, Springer New York Publisher.
3. David Grossman, Ophir Frieder, Information Retrieval - Algorithms and Heuristics, Springer International Edition, ISBN: 978-1-4020-3004-8.
4. Hang Li, Learning to Rank forInformation Retrieval and Natural Language. 7. Processing, Morgan & Claypool, ISBN: 9781608457076.
5. Robert Korfhage, Information Storage and Retrieval, John Wiley & Sons, First Edition,ISBN: 9788126507702.
6. 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 Artificial Intelligence and Machine Learning (2020 Course)

418542: Cloud Computing

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

Prerequisite Courses: Basics of Computer Networks, Operating System

Companion Course, if any: NIL

Course Objectives:

1. To learn the concept of cloud computing.
2. To have knowledge of the various issues in cloud computing
3. To know the emergence of the cloud as the next-generation computing paradigm.

Course Outcomes:

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

CO1: Explore the fundamentals of cloud computing
CO2: Illustrate cloud-enabling technology
CO3: Discuss cloud services types and providers
CO4: Discuss data storage in the cloud
CO5: Explore cloud security mechanisms
CO6: Examine common standards in cloud computing

COURSE CONTENTS

Unit I	Fundamentals of Cloud Computing	(06 hrs)

Understanding Cloud Computing: Origin and Influences- History, definitions, technology innovations; Cloud Computing terminologies, Applications, benefits and limitations, risk and challenges; Roles and Boundaries, Cloud characteristics, Cloud Delivery Models, Deployment Models.

Mapping of Course Outcomes for Unit I	CO1

Unit II	Common Enabling Technology	(06 hrs)

Hardware and Infrastructure:

Clients- mobile, thin, thick; Security- data leakage, offloading work, logging, forensics, development, auditing; Network-basic public Internet and accelerated Internet; Services- Identity, Integration, Mapping, Payments, Search.

Cloud Enabling Technology: Broadband Networks and Internet Architecture, Data Center Technology, Virtualization Technology, Web Technology, Multitenant Technology, Containerization

Mapping of Course Outcomes for Unit II	CO2

Unit III	**Cloud Services and Providers**	**(06 hrs)**
Cloud Service Types: Software as a Service, Platform as a Service, Infrastructure as a Service, Database as a Service, Monitoring as a Service, Communication as a service **Cloud Service Providers:** Google- Google App Engine, EMC- Technologies, VMware Acquisition, Microsoft- Azure Services Platform; Amazon- Amazon Elastic Compute Cloud (EC2), Amazon Simple DB, Amazon Simple Storage Service (S3), Elastic Block Store; Salesforce.com- Force.com, Salesforce.com CRM, AppExchange		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Data Storage in Cloud**	**(06 hrs)**
Cloud File System: GFS and HDFS, BigTable, HBase and Dynamo Cloud data stores: Datastore and Simple DB Gautam Shrauf, Cloud Storage-Overview, Cloud Storage Providers. Creating Cloud Storage Systems, Virtual Storage Containers, Challenges		
Mapping of Course Outcomes for Unit IV		
Unit V	**Cloud Security**	**(06 hrs)**
Cloud Security: Basic Terms and Concepts-Confidentiality, Integrity, Authenticity, availability, Threat, Vulnerability, Risk, Security Control, Security Mechanisms, and Security Policies. **Cloud Security Mechanism:** Encryption, Hashing, Digital Signature, Public Key Infrastructure (PKI), Identity and Access Management (IAM), Single Sign-On (SSO)		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Common Standards in Cloud Computing**	**(06 hrs)**
Open Cloud Consortium- Open Virtualization Format, Standards for Application Developers- browsers, data and solution Stack; Standards for Messaging- SMTP, POP, IMAP, RSS, HTTP; Standards for Security- Security (SAML OAuth, OpenID, SSL/TLS). Docker at a Glance: Process Simplification, Broad Support and Adoption, Architecture, Getting the Most from Docker, The Docker Workflow.		
Mapping of Course Outcomes for Unit VI	**CO6**	

Text Books:

1. Ricardo Puttini, Thomas Erl, and Zaigham Mahmood, “Cloud Computing: Concepts, Technology & Architecture”, Pearson May 2013, ISBN: 9780133387568.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, “Cloud Computing – A Practical Approach, Tata Mcgraw Hill, 2009.

E-Books / E-Learning References:

1. https://onlinecourses.nptel.ac.in/noc21_cs14/preview
2. https://nevonprojects.comextracurriculard-computing

Savitribai Phule Pune University, Pune Final Year Artificial Intelligence and Machine Learning (2020 Course) 418543: Deep Learning for AI		
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. Engineering Mathematics

Companion Course: Artificial Intelligence Soft computing

Course Objectives:

1. To introduce the theoretical foundations, algorithms, methodologies, and application of neural networksand deep learning.
2. To design and develop an application-specific deep learning model.
3. To analyze real-world AI applications.

Course Outcomes:

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

CO1. Comprehend 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 Networks and Recurrent Neural Networks and learn modelling the timedimension using RNN and LSTM.
CO4. Elaborate unsupervised deep learning algorithms like Auto-encoders.
CO5. Explore Representation Learning and Transfer Learning techniques using variants of CNN architecture.
CO6. Evaluate the performance of deep learning algorithms and provide solutions to 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, **Hyperparameters:** 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)**
Under complete Auto encoders, Regularized 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 Layer wise 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)**
Generative Adversarial Networks – Generator, Discriminator, Training, GAN variants; Autoencoder: Architecture. Denoising and Sparcity. Case Study - DALL-E, DALL-E 2 and IMAGEN		
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.

EE-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 Artificial Intelligence and Machine Learning (2020 Course)

418544A: Elective –III (Quantum computing)

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:

Course Objectives:

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

Course Outcomes:

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

CO1: Comprehend the concepts of Quantum Computing
CO2: Apprehend the mathematical foundation and quantum mechanics
CO3: Implement the building blocks of Quantum circuits
CO4: Comprehend the quantum information, its processing and Simulation tools
CO5: Understand basic signal processing algorithms FT, DFT and FFT
CO6: Solve examples of Quantum Fourier Transforms and their applications

COURSE CONTENTS

Unit I	Introduction to Quantum Computing	(06 hrs)

Fundamental Concepts of Quantum computing: Introduction and Overview, Global Perspective, Quantum Bits, Quantum Computation, Quantum Algorithms, Quantum Information and Quantum information processing, Comparison between classical and quantum computing, Quantum Computing Systems & Architecture, Quantum computing Application.

Mapping of Course Outcomes for Unit I	CO1

Unit II	**Mathematical Foundation of Quantum Computing**	**(06 hrs)**
Linear Algebra and Quantum mechanics, Postulates of Quantum mechanics, state space, evolution, Quantum measurement, distinguishing quantum states, projective measurements, POVM measurements, Phase, Composite systems, Global view and applications, Density operator, Quantum states in Hilbert space, The Bloch sphere, generalized measurements, no-cloning theorem.		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Building Blocks for Quantum Program**	**(06 hrs)**
Quantum Computations: Quantum circuits, Quantum algorithms and qubit operations, Controlled operations, Principal deferred and Principal implicit Measurements, Universal Quantum Gates, Two level unitary gates, single qubit and CNO, discrete set of universal operations, Quantum computational complexity, Postulates of Quantum Mechanics.		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Quantum Simulation Algorithms and Fourier Transform**	**(06 hrs)**
Simulation of Quantum Systems, Simulation in action, exponential complexity growth of quantum systems, Quantum simulation algorithm, examples of quantum simulations, perspectives of quantum simulation, Understanding Basics of Fourier transform, Discrete Fourier Transform, Fast Fourier Transform, Definitions, mathematical representations of Fourier Transform, discrete Fourier transform (DFT) and fast Fourier transform (FFT), Quantum Fourier Transform Shore's Factorization Algorithm		
Mapping of Course Outcomes for Unit IV	**CO3, CO4**	
Unit V	**Quantum Fourier Transform and Applications**	**(06 hrs)**
Quantum Fourier Transform, Phase estimation performance and requirements, order finding application, factoring application, General applications of Quantum Fourier transform, period finding, discrete algorithms, and Other Quantum Algorithms.		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Quantum Machine Learning**	**(06 hrs)**
Quantum Machine Learning and Quantum AI, Quantum Neural Networks, Quantum Natural Language Understanding, Quantum Cryptography, Application Domains for Quantum Machine Learning: Chemistry/Material Science, Space Tech, Finance related Optimisation Problems, Swarm Robotics, Cyber security.		

Mapping of Course Outcomes for Unit VI	CO6

Text Books:

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

Reference Books:

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

E-Books /E-Learning References:

(last refrred in July 2023)

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

MOOC Courses Links:

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

Savitribai Phule Pune University, Pune

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418544B: Elective –III (Blockchain Technology)

Home

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

Prerequisite Courses, if any:
Computer Network & security, Distributed systems

Course Objectives:

1. Basics of cryptography in blockchain technology.
2. 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 technology.

Course Outcomes:

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

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

COURSE CONTENTS

Unit I	Basics of Cryptography in Blockchain	(6hrs)

Cryptography in the blockchain: Types of cryptography, wallets and digital signatures, cryptography and hash function in blockchain, Cryptographic algorithm, Centralized and decentralized system, limitation of centralised system, Benefits of cryptocurrency.

Mapping of Course Outcomes for Unit I	CO1

Unit II	Introduction to Blockchain Technology	(6 hrs)

Introduction of Blockchain, History of Blockchain, Blockchain Technology Definition, Types of Block Chain, What is Bitcoin, Mechanics of Bitcoin, bitcoin transaction, Crypto wallets: Metamask, Coinbase, Binance.
Why use blockchain technology.

Mapping of Course Outcomes for Unit II	CO2

Unit III	Ethereum Blockchain	(6hrs)
Introduction to Ethereum Blockchain Platform, what is Ethereum, Ethereum features, Components of Ethereum Ecosystem, Ethereum Programming Languages, Runtime Byte Code, Blocks and Blockchain, How Smart Contracts Work. Ethereum Structure, Operations, Consensus Model, Incentive Model.		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Hyperledger Blockchain Platform**	**(6 hrs)**
What is Hyper ledger, what features of a Hyper ledger blockchain, How Does Hyper Ledger Fabric Work, The 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	**Basics of Tokenization**	**(6hrs)**
Introduction to Tokenization: the technology behind tokenization, how blockchain tokenization can help in enterprise systems, Tokenizing Shares and Fund Raising, challenges to tokenization and Consensus Mechanism.		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Blockchain 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:
(last referred in July 2023) 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

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Savitribai Phule Pune University, Pune

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418544C: Elective –III (AI in Drones)

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

Prerequisite Courses, if any: Artificial Intelligence

Companion Course, if any:

Course Objectives:

4. To understand the concept of drones.
5. To create an unmanned aerial vehicle.
6. To understand the working of AI in drones.

Course Outcomes:

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

CO1: Understand the fundamentals of drones.
CO2: Build a Quadcopter.
CO3: Comprehend the concept of the communication system.
CO4: Apprehend the concept of the Navigation system.
CO5: Analyze the basic flight control operations.
CO6: Analyze the working of AI in drones.

COURSE CONTENTS

Unit I	Introduction to Drone	(06 hrs)

Introduction to Drone, History of Drones, three terrains, anatomy of a Drone, unmanned aerial vehicle (UAV)- Functional Architecture, Types of Drones: Features and Differences.

Mapping of Course Outcomes for Unit I	CO1

Unit II	Quadcopter	(06 hrs)

Quadcopter- Choosing an Airframe, Choosing Between Commercial Options, MakerBeam Airframe – Parts and Steps. Motors and Props -Choose Your Motors, Outrunner Versus Inrunner, Brushed Versus Brushless, AC Versus DC, Choose Your Propellers, Prop Adapteand r, steps for Attaching the Props and Motors.

Mapping of Course Outcomes for Unit II	CO2

Unit III	Payload and Communication	(06 hrs)

Payload types- non-dispensable Payload, dispensable Payload.
Communication – Communication media, Radio Communication, Mid-air collision avoidance, Antenna types. Concept of kinematics and dynamics.

Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Navigation**	**(06 hrs)**

Global Positioning System, Inertial Navigation, Radio Tracking.
Path planning algorithm Waypoint navigation.
Control station composition.

Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Flight Control**	**(06 hrs)**

Radio Control – Transmitter, Receivers, ESC (Electronic Speed Controller), Flight Controller examples.

Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Real-World Applications and Case Studies**	**(06 hrs)**

Beneficial Drones, Aerial Photography, Mapping and Surveying, Precision Agriculture, Search and Rescue, and Infrastructure Inspection.

Case Study- SURVEILLANCE, Delivery Drones.

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

Text Books:

1. John Baichtal, Building Your Own Drones: A Beginner‘s Guide to Drones, UAVs, and ROVs, 2015
2. Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016.

Reference Books:

1. Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment. Wiley, 2010. 978-0- 470-05819-0
2. Creating Autonomous Vehicle Systems by Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot, Morgan & Claypool Publishers, 2018
3. Vasilis Tzivaras, “Building a Quadcopter with Arduino”, Packt Publishing, 2016.
4. Donald Norris, “Build Your Own Quadcopter -Power Up Your Designs with the Parallax Elev-8”, McGraw-Hill Education, 2014

E-Books/ E-Learning References :
1. https://www.wevolver.com/article/artificial-intelligence-in-drone-technology 2. https://www.analyticsinsight.net/what-is-the-role-of-artificial-intelligence-in-drone-technology/

Savitribai Phule Pune University, Pune

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418545A: Elective IV - (Ethical Hacking and Cyber Forensics)

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

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

Companion Course, if any: Certified Ethical Hacking (EC Council), Ethical Hacking NPTEL, Digital Forensic NPTEL.

Course Objectives:

1. Understand Importance of Ethical Hacking and Cyber Forensics
2. Apply Scanning, Enumeration with realistic approach and legalities Penetration Testing
3. Analyze Meta sploit tool with Kali Linux for penetration testing
4. Analyze Web application, Wireless Network security and Cryptography
5. Create awareness about Digital Forensics, Network Forensics & Mobile Device Forensics
6. Understand Future Emerging Technologies and Forensic Laws

Course Outcomes:

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

CO1: Identify Ethical hacking attempts and understand the cyber forensics processes.
CO2. Recognize Scanning techniques, penetration testing process and apply in real time applications
CO3. Build knowledge about Meta sploit tool with Kali Linux
CO4. Construct Secure Web Applications to understand Hacking Techniques.
CO5. Differentiate Digital Forensics, Network Forensics & Mobile Device Forensics
CO6. Identify Future Emerging Technologies and Forensic Laws

COURSE CONTENTS

Unit I	Introduction to Ethical Hacking and Cyber Forensics	(6 hrs)

Overview of ethical hacking and Cyber forensics , CIA(confidentiality, Integrity Availability , Types of Hackers , Ethical Hacking Process, roles and responsibilities of ethical hackers and cyber forensic investigators , Different tools for Ethical Hacking, Exploring common network vulnerabilities and attack vectors.

Mapping of Course Outcomes for Unit I	CO1

Unit II	Scanning, Testing and Enumeration	(6 hrs)

Information Gathering and Reconnaissance: Techniques for gathering information, open-source intelligence (OSINT), Using tools for passive and active reconnaissance, Scanning and Enumeration: **Scanning and Enumeration :** Techniques for scanning and identifying vulnerabilities, Exploring port scanning, network mapping, and service enumeration, Identifying weaknesses and potential entry points. **Penetration Test:** 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 II	**CO2**	
Unit III	**System Security and Hacking**	**(6 hrs)**
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	**Applications & Network Security**	**(6 hrs)**
Web Application Security: Understanding web application vulnerabilities and attacks, Introduction to OWASP Top 10 vulnerabilities, Web application penetration testing methodologies and tools. **Wireless Network Security:** Understanding wireless network vulnerabilities, Exploring common attacks on wireless networks (e.g., Wi-Fi hacking, rogue access points), Implementing wireless network security controls. **Cryptography and Steganography:** Introduction to encryption algorithms and protocols, Understanding cryptographic attacks and countermeasures, Exploring steganography techniques for hiding information.		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Digital Forensics, Network Forensics & Mobile Device Forensics**	**(6 hrs)**
Digital Forensics: Introduction to digital forensics methodologies and procedures, Collecting and analyzing digital evidence, Understanding file systems, disk imaging, and forensic analysis techniques. **Network Forensics:** Investigating network traffic and logs, Analyzing network-based attacks and intrusions, Using network forensics tools and techniques. **Mobile Device Forensics:** Understanding mobile device forensics procedures, Extracting and analyzing data from mobile devices, Investigating mobile device security incidents.		
Mapping of Course Outcomes for Unit V	**CO5**	

Unit VI	Future Emerging Technologies and Forensic Laws	(6 hrs)

Exploring emerging technologies and Trends: Cloud-based digital forensics, Internet of Things (IoT) forensics, Social Media forensics, Collaboration between digital forensics and cyber security.

Legal and Ethical Considerations: Understanding the legal and regulatory aspects of ethical hacking and cyber forensics,Ethical guidelines and professional conduct, Reporting and documentation in compliance with legal requirements.

Mapping of Course Outcomes for Unit VI	CO6

Text Books:

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. ThomasJ.Holt,AdamM. Bossler,Kathryn C. Seigfried-Spellar "Cybercrime and Digital Forensics"
4. Lei Chen, Hassan Takabi, Nhien-An Le-Khac, Security, Privacy, and Digital Forensics in the Cloud

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
4. Cyber Forensics, Oxford India by Dejey & S. Murugan.
5. Practical Mobile Forensics Forensically investigate and analyze iOS, Android, and Windows 10 devices, 4th Edition Rohit Tamma,Oleg Skulkin,Heather Mahalik,Satish Bommisetty

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.
11. Digital Forensics and Incident Response Training by EC-Council: https://www.eccouncil.org/programs/computer-hacking-forensic-investigator-chfi/
12. Open Source Digital Forensics Tools by The Sleuth Kit: https://www.sleuthkit.org/
13. Digital Forensics courses on Coursera: https://www.coursera.org/learn/digital-forensics-essentials-dfe
14. https://www.coursera.org/learn/digital-forensics-concepts
15. https://www.coursera.org/specializations/computerforensics

Savitribai Phule Pune University, Pune

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418545B: Elective IV- (Augmented and Virtual Reality)

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

Prerequisite Course: Computer Graphics

Companion Course: Object-Oriented Programming, Computer Graphics Lab and Authoring Tools

Course Objectives:

1. To study modern overviews on virtual reality and list the applications of VR.
2. To know the representation of the Virtual world in VR.
3. To Study the fundamentals of visual perception, motion and tracking in the 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 Acquire knowledge of VR and AR application areas and their development platforms.

Course Outcomes:

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

CO1. Analyze how Virtual Reality systems work.

CO2. Understand the representation of the 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. Explore the appropriate platforms for AR VR application development.

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-InputOutputput- 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	**Application Development Using Augmented Reality and Virtual Reality**	**(6hrs)**
Programming Languages for AR & VR applications: OOL concepts, C# with Unity C# for AR and VR, C++ with Unreal Engine **AR App Development with Unity**: SDK and Framewrks, VR Concept Integration, Setting up Unity with VR, Unity AR concepts, Working with AR Tools– ARCore, ARToolkitx ARCore, ARToolit Vuforia **Trending Application Areas** - Gaming and Entertainment, Architecture and Construction, Science and Engineering, Health and Medicine, Aerospace and Defence, Education, Telerobotics and Telepresence. **Uman Factors, Legal and Social Considerations** - Human Factors Considerations, Legal and Social Considerations, The Future.		
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 **4.** Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Steve Aukstakalnis Addison-Wesley Professional, September 2016, ISBN: 9780134094328 7.		

5. Beginning iOS AR Game Development Developing Augmented Reality Apps with Unity and C#, Allan Fowler, 1st Edition, Apress Publications, 2018, ISBN 978-1484236178
6. Learning C++ by Creating Games with UE4, William Sherif, Packt Publishing, 2015, ISBN 978-1-78439-657-2

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
5. https://www.coursera.org/learn/augmented-reality
6. https://www.coursera.org/specializations/unity-xr

Savitribai Phule Pune University, Pune

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418545C: Elective IV (DevOps in Machine Learning)

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: Machine Learning

Course Objectives:

1. To understand the need for DevOps as a software engineering practice.
2. To know and understand the concept of Continuous Integration Continuous Delivery (CICD).
3. To learn the concept of continuous deployment and monitoring strategies.
4. To learn various tools used in DevOps
5. To comprehend the concepts in MLOps
6. To learn deployment strategies in MLOps

Course Outcomes:

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

CO1. Understand the fundamental concepts of DevOps

CO2. Comprehend the concept of continuous integration and continuous delivery

CO3. Compare various stages of continuous deployment and monitoring strategies

CO4. Explore various tools to implement concepts in DevOps

CO5. Describe the concepts used in the automation of Machine Learning life cycle phases

CO6. Elaborate deployment strategies in MLOps

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 and Best Practices for Operations.

Mapping of Course Outcomes for Unit I	CO1

Unit II	Continuous Integration and Continuous Delivery	(6 hrs)

Implementing Continuous Integration-Version control, automated build, Continuous Integration Practices using Continuous Integration Software (Jenkins as an example tool), Jenkins Architecture, Integrating Source code management, build, testing tools etc., with Jenkins – plugins, Artefacts management, setting up the Continuous Integration pipeline, Continuous delivery to a staging environment or the pre-production environment, Self-healing systems.

Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Continuous Deployment and Continuous Monitoring**	**(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, 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 the dashboard, behaviour-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 III	**CO3**	
Unit IV	**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 **Virtualization and Containerization:** Virtualization, Virtualization vs Containerization, Containerization using Dockers, Docker Images, Micro-services and Containerization, orchestration, Difference between orchestration and automation		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Introduction to MLOps**	**(6hrs)**
What is MLOps & MLOps Motivation, Solutions and Future Trends, MLOps Components, Different Roles involved in MLOps (ML Engineering + Operations), Machine Learning Life Cycle, MLOps Vs DevOps, Tools to create ML pipelines		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**ML Model Deployment**	**(6hrs)**
MLOps Maturity Model Levels, MLOps - Stages Of CI / CD, Creating and deploying ML/AI models, ML Pipelines, automation of ML through Pipelines, Tools to create ML pipelines, Monitoring and Logging, Data Quality and Integrity, Model Retraining and Model replacement, Model Versioning, MLOps: Infrastructure, MLOps: Testing, Monitoring and Maintenance		
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		

4. Mark Treveil, Lynn Heidmann, What Is MLOps? O'Reilly

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

4. Sridhar Alla, Suman Kalyan Adari, Beginning MLOps with MLFlow: Deploy Models in AWS SageMaker, Google Cloud, and Microsoft Azure

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/
16. Coursera: Machine Learning Engineering for Production (MLOps) Specialization by Andrew Ng

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Savitribai Phule Pune University, Pune

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418546 : Lab Practice-III (Information Retrieval in AI Lab)

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical (PR): 4hrs/week	02 Credits	PR: 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 the 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 a 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 two students from each batch. However, all students must submit a soft copy in the form CD/DVD, and it 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 the performance of students considering the parameters

such as timely completion of the practical assignment, the methodology adopted for the implementation of the practical assignment, timely submission of assignment in the form of handwritten write-up along with results of the implemented assignment, attendance etc.

2. Examiners will judge the understanding of the concept by asking questions related to theory & laboratory assignments.

3. Appropriate knowledge of the usage of software and hardware related to respective laboratories should be a conscious effort and little contribution towards Green IT and the environment; 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 the 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 the 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 the laboratory.

Guidelines for Practical Examination

Both internal and external examiners should jointly conduct the Oral examination. During the assessment, the Examiners should give the maximum weightage to the satisfactory answer to 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(Any two)

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

Group B: CO3, 5(Any two)

1. Implement a program to calculate precision and recall for sample input. (Answer set A, Query q1, Relevant documents to query q1- Rq1)
2. Write a program to calculate the harmonic mean (F-measure) and E-measure for the above example.
3. Implement a program for feature extraction in 2D color images (any features like color, texture etc. and extract features from the input image and plot a histogram for the features.

Group C:CO4, 5(Any two)

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.

Reference Books:

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.

Virtual Laboratory :

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

Savitribai Phule Pune University, Pune

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418547 : Lab Practice-IV (Deep Learning for AI Lab)

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, optimise 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 deep Neural Network models for use in various applications.
CO3. Apply Deep Learning techniques like CNN and RNN Auto encoders to solve real word Problems.
CO4. Evaluate the performance of the model built 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 instructors/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. The candidate is expected to know the theory involved in the experiment.
3. 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 the performance of students considering the parameters such as timely conduction of practical assignment, the methodology adopted for the implementation of practical assignment, timely submission of assignment in the form of handwritten write-up along with the implemented assignment, attendance etc.
2. Examiners will judge the understanding of the practices performed in the examination by asking some questions related to the theory & implementation of experiments he/she has carried out.
3. Appropriate knowledge of the age 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 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 the practical assessment, maximum weightage should be given to the satisfactory implementation of the problem. Students' understanding of the fundamentals and the effective and efficient implementation can be evaluatedby asking relevant questions based on the 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 distinctfeatures and functionality of the packages.

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

2. Implementing Feed-forward 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 the following four 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 the following:
    - **a.** Import required libraries
    - **b.** Upload/access the dataset
    - **c.** The encoder converts it into a 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 the model's lower convolutional layers **c.** Add a custom classifier with several layers of trainable parameters to model **d.** Train classifier layers on training data available for the task **e.** Fine-tune hyperparameters 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 Vasilv, 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 Artificial Intelligence and Machine Learning (2020 Course) 418548: 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 skills, Teamwork and Leadership Qualities, and professionalism.
4. To apply the knowledge for solving real 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. Apply knowledge of mathematics, science, and engineering to formulate the Problem statement.

CO2. Design and conduct experiments, as well as to analyse and interpret data.

CO3. Comprehend the professional and ethical responsibility.

CO4. Communicate effectively.

CO5. Acquire the broad education which is necessary to understand the impact of engineering solutions in aglobal, economic, environmental, and societal context.

CO6. Recognize of the need for an ability to engage in life-long learning.

CO7. Use the techniques, skills, and modern engineering tools necessary for engineering practices.

CO8. Design a system, component, or process to meet desired needs within realistic constraints suchas 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, and Theoretical Computer Science fundamentals. In Project Phase-I, thestudent will undertake a project over the academic year, which will involve the analysis and design of a 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 one 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 the same committee needs to carry throughout the year) for the project group; the project guide would be one member of that committee by default.
2) For sponsored projects, an employee of the sponsoring organization may be one member of the review committee.
3) There shall be **TWO** reviews in Phase –I (in Semester-I) by the review committee.
4) The Project 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 Students.
5) Students should identify a 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...a detailed problem statement and the review system.
7) Review and finalize the scope of the project.
8) If a change in the project topic is unavoidable, then the students should complete the process of Project approval by submitting a 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 implemented 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) Concrete 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 a suitableformat.
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

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418549A: 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-partees 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

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

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418549B: 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: Stress, 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 (Publication Department), 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

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418549C: 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 Curriculumof 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 Heidelberg London,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 Artificial Intelligence and Machine Learning (2020 Course)

418550: Natural Language Processing

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

Prerequisite Course : Discrete Mathematics, Theory of Computation

Companion Course: Object Oriented Programming, Computer Graphics Lab and Authoring Tools

Course Objectives:

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

Course Outcomes:

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

CO1. Describe the fundamental concepts of NLP, challenges and issues in NLP.
CO2. Analyze Natural languages morphologically, syntactical and semantically
CO3. Illustrate various language modelling techniques
CO4. Integrate the NLP techniques for the information retrieval task.
CO5. Demonstrate the use of NLP tools and techniques for text-based processing of natural languages.
CO6. Develop real world NLP applications.

COURSE CONTENTS

Unit I	Introduction to Natural Language Processing	(6 hrs)

Introduction: Natural Language Processing, Why NLP is hard? Programming languages Vs Natural Languages, Are natural languages regular? Finite automata for NLP, Stages of NLP, Challenges and Issues(Open Problems) in NLP

Basics of text processing: Tokenization, Stemming, Lemmatization, Part of Speech Tagging

Mapping of Course Outcomes for Unit I	CO1

Unit II	Language Syntax and Semantics	(6 hrs)

Morphological Analysis: What is Morphology? Types of Morphemes, Inflectional morphology & Derivational morphology, Morphological parsing with Finite State Transducers (FST) Syntactic Analysis: Syntactic Representations of Natural Language, Parsing Algorithms, Probabilistic context-free grammars, and Statistical parsing

Semantic Analysis: Lexical Semantic, Relations among lexemes & their senses Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Word Sense Disambiguation (WSD), Dictionary based approach, Latent Semantic Analysis

Mapping of Course Outcomes for Unit II	CO2

Unit III	Language Modelling	(6 hrs)

Probabilistic language modelling, Markov models, Generative models of language, Log-Liner Models, Graph-based Models N-gram models: Simple n-gram models, Estimation parameters and smoothing, Evaluating language models, Word Embeddings/ Vector Semantics: Bag-of-words, TFIDF, word2vec, doc2vec, Contextualized representations (BERT) Topic Modelling: Latent Dirichlet Allocation (LDA), Latent Semantic Analysis, Non Negative Matrix Factorization.		
Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Information Retrieval using NLP**	**(6 hrs)**
Information Retrieval: Introduction, Vector Space Model Named Entity Recognition: NER System Building Process, Evaluating NER System Entity Extraction, Relation Extraction, Reference Resolution, Coreference resolution, Cross Lingual Information Retrieval		
Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**NLP Tools and Techniques**	**(6 hrs)**
Prominent NLP Libraries: Natural Language Tool Kit (NLTK), spaCy, TextBlob, Gensim etc. Linguistic Resources: Lexical Knowledge Networks, WordNets, Indian Language WordNet (IndoWordnet), VerbNets, PropBank, Treebanks, Universal Dependency Treebanks Word Sense Disambiguation: Lesk Algorithm WordNets for Word Sense Disambiguation		
Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Applications of NLP**	**(6hrs)**
Machine Translation: Rule based techniques, Statistical Machine Translation (SMT), Cross Lingual Translation Sentiment Analysis, Question Answering, Text Entailment, Discourse Processing, Dialog and Conversational Agents, Natural Language Generation		
Mapping of Course Outcomes for Unit VI	**CO6**	

Textbooks:

1. Jurafsky, David, and James H. Martin Speech and Language Processing: An Introduction to Natural Language Processing , Computational Linguistics and Speech PEARSON Publication

2. Manning, Christopher D., and nrich Schütze Foundations of Statistical Natural Language Processing, Cambridge, MA: MIT Press

Reference Books:
1. Steven Bird, Ewan Klein, Edward Loper Natural Language Processing with Python Analysing Text with the Natural Langua Publication 2. Dipanjan text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from your Publication ISBN: 9781484223871 3. Alexander Clark, Chris Fox, and Shalom Lappin The Handbook of Computational Linguistics and Natural Language Processing, Wiley Blackwell Publications 4. Jacob Eisenstein Natural Language Processing, MIT Press 5. Jacob Eisenstein An Introduction to Information Retrieval Cambridge University Press
E Books / E Learning References:
1. https://web.stanford.edu/~jurafsky/slp3/ed3book.pdf 2. https://www3.cs.stonybrook.edu/~cse521/L16NLP.pdf 3. https://nptel.ac.in/courses/106101007 4. https://nptel.ac.in/courses/106106211

Savitribai Phule Pune University, Pune

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418551A: Elective V- (Distributed Systems)

eaching 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 understand the fundamental concepts and principles of distributed systems.
2. To gain knowledge and skills in using middleware technologies for distributed systems.
3. To develop an understanding of different inter-process communication mechanisms in distributed systems.
4. To learn about replication techniques and fault tolerance mechanisms in distributed systems.
5. To explore the design and implementation of distributed file systems, multimedia systems, and web-based systems.
6. To stay updated with the latest trends and advancements in distributed systems.

Course Outcomes:

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

CO1. Analyze and evaluate the design choices and trade-offs involved in building distributed systems.
CO2. Design and implement efficient distributed systems using middleware.
CO3. Design and implement effective inter-process communication strategies in distributed systems.
CO4. Develop fault-tolerant distributed systems by implementing replication and fault tolerance strategies.
CO5. Apply distributed file, multimedia, and web-based systems to real-world scenarios.
CO6. Incorporate recent trends and technologies in the design and implementation of 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: Google File System (GFS)

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: -** Apache Kafka		
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:** Amazon DynamoDB		
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:** 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:** Kubernetes	
Mapping of Course Outcomes for Unit VI	**CO6**

Textbooks:

1. Distributed Systems: Concepts and Design by George Coulouris, J Dollimore and Tim Kindberg, Pearson Education, ISBN: 9789332575226, 5th Edition, 2017.
2. Distributed Systems, Maarten van Steen, Andrew S. T,ThirdeditionVersion. Andrew S. Tanenbaum, Maarten van Steen, PHI ,2nd Edition, ISBN: 978-0130888938
3. 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, Hagit Attiya and Jennifer Welch, Wiley India
3. Tool for Distributed Systems Monitoring, Łukasz KUFEL, Foundation of Computing and DecisionSciences, 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 Artificial Intelligence and Machine Learning (2020 Course)

418551B: Elective V- (Software Project Management)

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

Prerequisite Courses, if any: Software Engineering

Companion Course:---

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. Use various tools of Software Project Management
CO3. 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. Analyse a case study for a distributed team and comment.
CO6. Discuss and use modern tools for Software Project Management.

COURSE CONTENTS

Unit I	Introduction to Software Project Management	(6 hrs)

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**.**

Mapping of Course Outcomes for Unit I	CO1
Case study:	Online Shopping System

Unit II	Project Planning and Project Management Tools	(6 hrs)

Project Planning: Steps for Project Planning, PERT and Gantt Charts, Gantt Project, Microsoft Project and Primavera Project Management Software, Objectives of Activity planning, Project Schedules, Activities, Sequencing and Scheduling, Network Planning Models, Formulating Network Model.

Mapping of Course Outcomes for Unit II	CO2

Case study:	**Software project plan using any tool.**	
Unit III	**Project Design Evaluation and Risk Management**	**(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. **Risk Management:** Introduction, Risk Management, Risk Assessment, Risk identification, Risk Prioritization, Risk Planning, Risk control, Risk Strategies, Evaluating Risk to the schedule.		
Mapping of Course Outcomes for Unit III	**CO3,CO4**	
Case study:	**Online Shopping System, Perform Cost Benefit Analysis using Microsoft Excel**	
Unit IV	**Project Tracking and Control**	**(6 hrs)**
Introduction: Project Tracking and Control, Monitoring and Control Processes, Collection of Project data, Partial Completion Reporting. **Data Collection Methods:** Phone vs. Online vs. InPerson 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 FlowDiagram, 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		
Mapping of Course Outcomes for Unit IV	**CO4**	
Case study:	**Online Shopping System, track different versions of a software using Git tool**	
Unit V	**Staffing and Team organization in Software Projects**	**(6 hrs)**
Managing People, Organizational behaviour, Best methods of Staff Selection, Motivation, The Oldham, Hackman job characteristic Model, Stress, Health and Safety, Ethical and Professional concerns, working in Teams, Decision Making, Organizational structures, Dispersed and Virtual Teams, Communications Genres, Communication Plans.		
Mapping of Course Outcomes for Unit V	**CO5**	
Case study:	**Team Building in Project Management with reference to academic project work.**	
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.	
Mapping of Course Outcomes for Unit VI	**CO6**
Case study:	**Online Shopping System.**

Text Books:

1. Bob Hughes, Mike Cotterell and Rajib Mall: Software Project Management – FifthEdition, Tata McGrawHill, New Delhi.
2. A Guide to the Project Management Book of Knowledge-Seventh Edition.
3. Walker Royce, "Software Project Management" a unified approach. Addison Wesley ISBN 0-20130958-0.
4. Robert K. Wysocki, "Effective Software Project Management", Wiley Publication, 2011

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

E Books / E Learning References :

1. https://www.inflectra.com/SpiraPlan/(for Unit 3)
2. https://www.techtarget.com/searchsecurity/definition/governance-risk-management-andcompliance-GRC(for Unit 3)
3. https://www.softwaretestinghelp.com/risk-management-tools/#3_Risk_Management_Studio
1. (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-
    i http://vlabs.iitkgp.ernet.in/se/3/
    ii http://vlabs.iitkgp.ernet.in/se/5/
    iii http://vlabs.iitkgp.ernet.in/se/6/
    iv http://vlabs.iitkgp.ernet.in/se/7/

Savitribai Phule Pune University, Pune

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418551C: Elective V- (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 motion detection 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. Implement three-dimensional analysis techniques.
CO5. Implement Motion detection and object tracking techniques.
CO6 Develop skills to implement diverse computer vision applications.

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 Artificial Intelligence and Machine Learning (2022 Course)
418552A: Elective VI- (Reinforcement Learning)

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: Linear algebra, multivariable calculus, Basic machine learning knowledge

Companion Course, if any: https://nptel.ac.in/courses/106106143

Course Objectives:

1. To familiarize the students with the basic concepts in deep reinforcement learning.
2. To Compare and contrast different learning algorithms with parameters.
3. To Examine the nature of a problem at hand and find the appropriate reinforcement learning algorithms and its parameters that can solve it efficiently enough.
4. To Design and implement of deep and reinforcement learning approaches for solving real-life problems.

Course Outcomes:

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

- **CO1:** Describe about theories and process in a reinforcement learning problem
- **CO2:** Understand and apply basic Reinforcement Learning algorithms for simple sequential decision making problems in uncertain conditions
- **CO3:** Evaluate the performance of the solution and find optimal strategy.
- **CO4:** Understand how to fine tune the target to have better learning performance.
- **CO5:** Learn approximation methods and algorithms for optimizing the problem.
- **CO6:** Understand to decompose a reinforcement learning problem into hierarchy of sub problems or sub tasks.

COURSE CONTENTS

Unit I	Reinforcement Learning Problem	(06 hrs)
The Reinforcement Learning problem: evaluative feedback, nonassociative learning, Rewards and returns, Markov Decision Processes, Value functions, optimality and approximation		
Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**Bandit Problems & Dynamic Programming**	**(06 hrs)**
Bandit Problems: Explore-exploit dilemma, Binary Bandits, Learning automata, exploration schemes Dynamic programming: value iteration, policy iteration, asynchronous DP, generalized policy iteration		
Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Monte Carlo Methods and Temporal Difference Learning**	**(06 hrs)**

Monte-Carlo methods: policy evaluation, roll outs, on policy and off policy learning, importance sampling Temporal Difference learning: TD prediction, Optimality of TD(0), SARSA, Q-learning, R-learning, Games and after states

Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Eligibility Traces**	**(06 hrs)**

Eligibility traces: n-step TD prediction, TD (lambda), forward and backward views, Q(lambda), SARSA(lambda), replacing traces and accumulating traces

Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Function Approximation**	**(06 hrs)**

Function Approximation: Value prediction, gradient descent methods, linear function approximation, Control algorithms, Fitted Iterative Methods Policy Gradient methods: non-associative learning - REINFORCE algorithm, exact gradient methods, estimating gradients, approximate policy gradient algorithms, actor-critic methods

Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Hierarchical Reinforcement Learning**	**(06 hrs)**

Hierarchical RL: MAXQ framework, Options framework, HAM framework, Option discovery algorithms Case studies: Elevator dispatching, Samuel's checker player, TDgammon, Acrobot, Helicopter piloting, Computational Neuroscience

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

Text Books:

1. R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. 1998.
2. Csaba Szepesvari. Algorithms for Reinforcement learning. Morgan & Claypool Publishers.
3. Marco Wiering and Martijn van Otterlo, Eds. Reinforcement Learning: State-of-the-Art. Sprinkler.
4. Stuart J. Russell and Peter Norvig. Artificial Intelligence: A Modern Approach. Pearson.
5. Ian Goodfellow, Yoshua Bengio,and Aaron Courville. Deep Learning. MIT Press.

Reference Books:

1. Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, Eds.(Reinforcement Learning: State-of-the-Art | SpringerLink)
2. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig. (Artificial Intelligence: A Modern Approach, 4th US ed. (berkeley.edu))
3. Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville. (Deep Learning (deeplearningbook.org))
4. David Silver's course on Reiforcement Learning

E Books / E Learning References:
1. https://nptel.ac.in/courses/106106143 2. http://cse.iitkgp.ac.in/~aritrah/course/theory/RL/Autumn2022 3. https://onlinecourses.nptel.ac.in/noc20_cs74/preview 4. https://www.davidsilver.uk/teaching/

Savitribai Phule Pune University, Pune Final Year Artificial Intelligence and Machine Learning (2020 Course) 418552B: Elective VI- (BigData Analytics)		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Theory (TH) : 3 hrs/week	**03 Credits**	**Mid_Semester : 30 Marks** **End_Semester : 70Marks**

Prerequisite Courses, if any: Should have knowledge of one Programming Language (Java preferably), Practice of SQL (queries and sub queries), exposure to Linux Environment.

Companion Course, if any: Big Data Computing by PROF. RAJIV MISRA, Dept. of Computer Science and Engineering, IIT Patna.

Course Objectives:

1. Understand the Big Data Platform and its Use cases
2. Provide HDFS Concepts and Interfacing with HDFS
3. Understand Map Reduce Jobs
4. Provide hands on Hodoop Eco System
5. Exposure to Data Analytics with R
6. Understand Future Emerging tools for Data Analytics.

Course Outcomes:

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

CO1 : Identify Big Data and its Business Implications.
CO2 : List the components of Hadoop and Hadoop Eco-System
CO3 : Manage Job Execution in Hadoop Environment
CO4 : Develop Big Data Solutions using Hadoop Eco System
CO5 : Apply Machine Learning Techniques using R.
CO6 : Analyze Infosphere BigInsights Big Data Recommendations.

COURSE CONTENTS

Unit I	**Introduction To Big Data and Bigdata Analytics**	**(6 hrs)**

Introduction to big data: Data, Characteristics of data and Types of digital data: Unstructured, Semi-structured and Structured, Sources of data, Working with unstructured data, Evolution and Definition of big data, Characteristics and Need of big data, Challenges of big data, Data environment versus big data environment

Big data analytics: Data science and Analytics, Meaning and Characteristics of big data analytics, Need of big data analytics, Classification of analytics, Challenges to big data analytics, Importance of big data analytics, Basic terminologies in big data environment

Mapping of Course Outcomes for Unit I	**CO1**	
Unit II	**HDFS (Hadoop Distributed File System)**	**(6 hrs)**

History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Mongodb and Mapreduce Programming**	**(6 hrs)**

Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features. Introduction to MongoDB and its needs, Characteristics of MongoDB.

Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Hadoop Eco System**	**(6 hrs)**

Pig : Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. **Hive :** Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. **Hbase :** HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL : Introduction

Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Data Analytics with R**	**(6 hrs)**

Big Data Analytics with BigR. Exploratory Data Analysis, Linear (Multiple Regression) Models and Analysis of Variance.

Graphical Data Analysis with R :Various types of plots drawn in R programming, Appropriate Graph in R, R Graphical Models, Types , Conditional Independence in Graphs

Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Recent Trends in Big data : Spark, Cassandra, Xplenty**	**(6 hrs)**

Streaming Analytics, Rise of AI-Powered BigData Analytics, DataOps for Data, Dark Data, Real-time Analytics.
Tools: Spark, Cassandra, Xplenty.

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

Text Books:

1. Tom White " Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012.
2. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015. References
3. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
4. Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013)
5. Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop", McGraw-Hill/Osborne Media (2013), Oracle press.

Reference Books:

1. Anand Rajaraman and Jef rey David Ulman, "Mining of Massive Datasets", Cambridge University Press, 2012. • Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.
2. Glen J. Myat, "Making Sense of Data", John Wiley & Sons, 2007
3. Pete Warden, "Big Data Glossary", O'Reily, 2011.
4. Michael Mineli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publications, 2013.
5. ArvindSathi, "BigDataAnalytics: Disruptive Technologies for Changing the Game", MC Press, 2012 • Paul Zikopoulos ,Dirk DeRoos , Krishnan Parasuraman , Thomas Deutsch , James Giles , David Corigan , "Harness the Power of Big Data The IBM Big Data Platform ", Tata McGraw Hill Publications, 2012.

E Books / E Learning References :

1. https://archive.nptel.ac.in/courses/106/104/106104189/
2. https://www.coursera.org/learn/introduction-to-big-data-with-spark-hadoop

Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
418552C: Elective VI- (Artificial Intelligence using R programming)

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

Prerequisite Courses, if any: Python programming , Fundamentals of AI

Companion Course, if any: Statistics, Machine Learning

Course Objectives:

1. To understand the basics in R programming in terms of constructs, control statements, string functions.
2. To be able to appreciate and apply the R programming from a statistical perspective.
3. To understand the concept of regression
4. To implement Machine learning algorithms using R

Course Outcomes:

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

CO1: Understand the use of R programming language.
CO2: Use programming structures like loops, functions, exceptions in R.
CO3: Understand the basic terminologies of statistics used in AI.
CO4: Understand the basic terminologies of probability used in AI.
CO5: To understand the concept of regression.
CO6: To implement Machine learning algorithms using R.

COURSE CONTENTS

Unit I	Introduction to R	(6 hrs)

Getting Started : Obtaining and Installing R from CRAN, Opening R for the First Time: Console and Editor Panes, Comments, Working Directory , Installing and Loading R Packages, Help Files and Function Documentation, Third-Party Editors, Workspaces, Scripts, Conventions: Coding, Math and Equation References

Numerics, Arithmetic assignment and vectors : R for Basic Math, Arithmetic, Logarithms and Exponentials, E-Notation, Assigning Objects, Vectors : Creating a Vector, Sequences, Repetition, Sorting, and Lengths, Subsetting and Element Extraction, Vector-Oriented Behavior

Conditions and loops : if Statements, Stand-Alone Statement, else Statements, Using if else for Element-wise Checks, Nesting and Stacking Statements, the switch Function .

Mapping of Course Outcomes for Unit I	CO1

Unit II	Programming in R	(6 hrs)

Coding Loops : for Loops, while Loops ,Implicit Looping with apply , Declaring break or next ,The repeat Statement

Writing functions : The function Command, Function Creation ,Using return, Arguments ,Lazy Evaluation, Setting Defaults ,Checking for Missing Arguments ,Dealing with Ellipses ,Specialized Functions , Helper Functions ,Disposable Functions ,Recursive Functions

Exceptions, timings and Visibility : Exception Handling , Errors and Warnings ,Catching Errors with try Statements ,Progress and Timing , Textual Progress Bars, Measuring Completion Time

Mapping of Course Outcomes for Unit II	**CO2**	
Unit III	**Statistics**	**(6 hrs)**

Elementary statistics: Describing Raw Data , Numeric Variables, Categorical Variables, Univariate and Multivariate Data

Summary Statistics : Centrality: Mean, Median, Mode , Counts, Percentages, and Proportions, Quantiles, Percentiles, and the Five-Number Summary , Spread: Variance, Standard Deviation, and the Interquartile Range ., Covariance and Correlation , Outliers

Mapping of Course Outcomes for Unit III	**CO3**	
Unit IV	**Probability**	**(6 hrs)**

Data Visualization : Barplots and Pie Charts, Building a Barplot , A Quick Pie Chart , Histograms , Box-and-Whisker Plots, Stand-Alone Boxplots, Side-by-Side Boxplots, Scatterplots, Single Plot, Matrix of Plots

Probability : What Is a Probability? ,Events and Probability , Conditional Probability, Intersection ,Union, Complement, Random Variables and Probability Distributions, Realizations, Discrete Random Variables ,Continuous Random Variables ,Shape, Skew, and Modality

Mapping of Course Outcomes for Unit IV	**CO4**	
Unit V	**Simple Linear Regression**	**(6 hrs)**

General Concepts : Definition of the Model, Estimating the Intercept and Slope Parameters , Fitting Linear Models with lm , Illustrating Residuals,

Statistical Inference : Summarizing the Fitted Model Regression, Coefficient Significance Tests, Coefficient of Determination

Prediction : Confidence Interval or Prediction Interval? , Interpreting Intervals, Plotting , Interpolation vs. Extrapolation, Understanding Categorical Predictors, Binary Variables: k = 2 , Multilevel Variables: k > 2, Changing the Reference Level , Treating Categorical Variables as Numeric

Mapping of Course Outcomes for Unit V	**CO5**	
Unit VI	**Multiple Linear Regression**	**(06 hrs)**

Terminology , **Theory** : Extending the Simple Model to a Multiple Model, Estimating in Matrix form **Implementing in R and Interpreting** : Additional Predictors, Interpreting Marginal effects, Visualizing the Multiple Linear Model , Finding Confidence Intervals , Omnibus F-Test, Predicting from a Multiple Linear Model **Machine Learning in Action** : Packages, Dataset , Data partitioning , Linear model , Prediction , Logistic regression , Residuals, Least squares regression , Relative importance , Stepwise regression , The k-nearest neighbor classification , Naïve Bayes , **The train Method** : Support vector machines, K-means clustering , Decision trees , AdaBoost , Neural network ,Random forests

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

Text Books:

1. "The book of R : A first course in programming and statistics ", Tilman A. Davies, No Starch press
2. "R for Data Science: Learn and explore the fundamentals of data science with R", Dan Toomey, Packt Publishing

Reference Books:

1. Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison-Wesley Data & Analytics Series, 2013.
2. Mark Gardener, " Beginning R – The Statistical Programming Language", Wiley, 2013
3. Robert Knell, "Introductory R: A Beginner's Guide to Data Visualisation, Statistical Analysis and Programming in R", Amazon Digital South Asia Services Inc, 2013.'

Savitribai Phule Pune University, Pune Final Year Artificial Intelligence and Machine Learning (2020 Course) 418553: 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 able to:-

CO1. understand key concepts and framework of innovation and start-up ecosystem.
CO2. gain knowledge of how to develop start up ecosystem, its key components and how to influence and managedynamics between them and increase the productivity of ecosystem.
CO3. understand the role of different stakeholders in ecosystem in building and supporting growth of start-ups.
CO4. have insight into global trend in start-up ecosystem and product development.
CO5. 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:		

1. https://www.forbes.com/sites/palomacanterogomez/2019/04/10/how-to-frame-a-problem-to-find-the-right-solution/?sh=13af54355993
2. https://hbswk.hbs.edu/item/how-entrepreneurs-can-find-the-right-problem-to-solve
3. https://www.youtube.com/watch?v=6y3WIrgp_NY
4. https://hbr.org/2014/07/what-you-need-to-know-about-segmentation
5. https://www.youtube.com/watch?v=ReM1uqmVfP0
6. https://www.youtube.com/watch?v=w62zW30PKms
7. https://www.youtube.com/watch?v=FULiFueLGzE
8. https://www.youtube.com/watch?v=7o8uYdUaFR4
9. https://steveblank.com/2021/04/20/the-secret-to-the-minimum-viable-product/
10. https://www.youtube.com/watch?v=1hHMwLxN6EM
11. https://www.youtube.com/watch?v=4uGx14UVWPc
12. https://www.youtube.com/watch?v=OVnN4S52F3k
13. https://www.entrepreneur.com/article/251687
14. https://www.forbes.com/sites/forbesbusinessdevelopmentcouncil/2020/09/14/13-key-steps-to-developing-a-go-to-market-strategy/?sh=53023c476fc1
15. https://www.garyfox.co/business-model/business-model-channels/
16. https://www.forbes.com/sites/allbusiness/2019/05/25/small-business-website-tips/?sh=2c551a0421ad
17. https://www.forbes.com/sites/forbesagencycouncil/2020/10/08/digital-marketing-best-practices- for-startups/?sh=2e55af9e3ded

Savitribai Phule Pune University, Pune

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418554 : Lab Practice V (Natural Language Processing)

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

Prerequisite Course : Discrete Mathematics, Theory of Computation

Companion Course: Python Programming

Course Objectives:

- To understand the fundamental concepts and techniques of natural language processing (NLP)

Course Outcomes:

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

Course Outcomes:

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

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

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

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

CO4: Generate and manage deployment, administration & security.

Natural Language Processing

Any 5 Assignments and 1 Mini Project are mandatory

Group 1

1. Perform tokenization (Whitespace, Punctuation-based, Treebank, Tweet, MWE) using NLTK library. Use porter stemmer and snowball stemmer for stemming. Use any technique for lemmatization.
2. Perform bag-of-words approach (count occurrence, normalized count occurrence), TF-IDF on data. Create embeddings using Word2Vec.
3. Perform text cleaning, perform lemmatization (any method), remove stop words (any method), label encoding. Create representations using TF-IDF. Save outputs.
4. Create a transformer from scratch using the Pytorch librar
5. Morphology is the study of the way words are built up from smaller meaning bearing units. Study and understand the concepts of morphology by the use of add delete table

Group 2 Mini Project

1. Fine tune a pre-trained transformer for any of the following tasks on any relevant dataset of your choice:
   - Neural Machine Translation
   - Classification
   - Summarization
2. POS Taggers For Indian Languages
3. Feature Extraction using seven moment variants
4. Feature Extraction using Zernike Moments

Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
418555A : LAB PRACTICE-VI (Reinforcement Learning)

Home

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical (PR) : 02 hrs/week	01	Term Work: 25 Oral : 50

Prerequisites: Basic Machine Learning Knowledge

Course Objectives:

1. To familiarize the students with the basic concepts in deep reinforcement learning.
2. To Compare and contrast different learning algorithms with parameters.
3. To Examine the nature of a problem at hand and find the appropriate reinforcement learning algorithms and its parameters that can solve it efficiently enough.
4. To Design and implement of deep and reinforcement learning approaches for solving real-life problems.

Course Outcomes:

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

- **CO1:** Describe about theories and process in a reinforcement learning problem
- **CO2:** Understand and apply basic Reinforcement Learning algorithms for simple sequential decision making problems in uncertain conditions
- **CO3:** Evaluate the performance of the solution and find optimal strategy.
- **CO4:** Understand how to fine tune the target to have better learning performance.
- **CO5:** Learn approximation methods and algorithms for optimizing the problem.
- **CO6:** Understand to decompose a reinforcement learning problem into hierarchy of sub problems or sub tasks.

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.
2. Use of open source software is to be encouraged. Assignments may be carried out in Python or Java.
3. All assignments are compulsory.

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. Oral Examination will be based on the term work.
3. Candidate is 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 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 student as per the oral 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 examination will be based on all assignments.

List of Laboratory Assignments

1. Write a program in python to demonstrate evaluative feedback by running episodes in the CartPole environment and printing the total reward accumulated in each episode.
2. Write a program in python to demonstrate Markov Decision Processes and value functions by performing value iteration to find the optimal value function for a randomly initialized MDP.
3. Write a program to demonstrate the explore-exploit dilemma by implementing an epsilon-greedy algorithm for solving a multi-armed bandit problem. It should maintain estimates of action values and uses an exploration rate (epsilon) to balance exploration and exploitation
4. Write a program to simulate a binary bandit problem, where each action has a binary (0 or 1) reward. It should use the upper confidence bound algorithm to estimate action values and make decisions based on the highest estimated value.
5. Write a program to estimate the value function for a given policy by iteratively simulating episodes and updating the value function based on the observed returns.
6. Write a program in python to demonstrates SARSA, an on-policy TD learning algorithm.
7. Write a program in python to demonstrate n-step TD prediction using eligibility traces by estimating the value function by iteratively simulating episodes and updating the value function based on n-step returns
8. Write a program to demonstrate the REINFORCE algorithm for policy gradient methods
9. Write a program in python to simulates the elevator's movement between floors, and the agent uses Q-learning to learn the optimal actions for each floor.

Reference Books:

1. **Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, Eds.(Reinforcement Learning: State-of-the-Art | SpringerLink)**
2. **Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig. (Artificial Intelligence: A Modern Approach, 4th US ed. (berkeley.edu))**

3. Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville. (Deep Learning (deeplearningbook.org)
4. David Silver's course on Reinforcement Learning

Virtual Laboratory

5. https://nptel.ac.in/courses/106106143
6. http://cse.iitkgp.ac.in/~aritrah/course/theory/RL/Autumn2022
7. https://onlinecourses.nptel.ac.in/noc20_cs74/preview
8. https://www.davidsilver.uk/teaching/

Savitribai Phule Pune University, Pune
Final Year Artificial Intelligence and Machine Learning (2020 Course)
418555B : Lab Practice VI (Big data analytics)

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical (PR): 02 hrs/week	01	Term Work: 25 Oral : 50

Prerequisite Courses, if any: Database Management Systems

Companion Course, if any: Practical hands on is the absolute necessity as far as employability of the learner is concerned. The presented course is solely intended to enhance the competency by undertaking the laboratory assignments of the core courses.

Course Objectives:

1. To develop problem solving abilities using Mathematics
2. To apply algorithmic strategies while solving problems
3. To develop time and space efficient algorithms
4. To study algorithmic examples in distributed, concurrent and parallel environments

Course Outcomes:

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

CO1: Write case studies in Business Analytic and Intelligence using mathematical models

CO2: Present a survey on applications for Business Analytic and Intelligence

CO3: Provide problem solutions for multi-core or distributed, concurrent/Parallel environments

Guidelines for Laboratory Conduction

- List of recommended programming assignments and sample mini-projects is provided for reference.
- Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses.
- Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
- Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
- Mini-project can be completed in group of 2 to 3 students.
- Software Engineering approach with proper documentation is to be strictly followed.
- Use of open source software is to be encouraged.
- Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.
- Operating System recommended :- 64-bit Open source
- Programming Languages: PYTHON/R
- Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net,
- Backend :MongoDB/MYSQL/Oracle,
- Database Connectivity: ODBC/JDBC, Additional Tools: Octave, Matlab, WEKA.

Guidelines for Instructor's Manual
The instructor‟s manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, references among others.
Guidelines for Student Journal
The laboratory assignments are to be submitted by student in the form of journal. Journal may consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software and Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, Algorithm/Database design, test cases, conclusion/analysis). **Program codes with sample output of all performed assignments are to be submitted as softcopy.** As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Use of digital storage media/DVD containing student's programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.
Guidelines for Lab /TW Assessment
Continuous assessment of laboratory work is to be done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness reserving weightage for successful mini-project completion and related documentation.
Guidelines for Practical Examination
• Both internal and external examiners should jointly frame suitable problem statements for practical examination based on the term work completed. • During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement. • The supplementary and relevant questions may be asked at the time of evaluation to test the student‟s for advanced learning, understanding of the fundamentals, effective and efficient implementation. • Encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising boost to the student's academics.

Perform any 4 assignment and mini-project is compulsory

1. Download the Iris flower dataset or any other dataset into a DataFrame. (eg https://archive.ics.uci.edu/ml/datasets/Iris) Use Python/R and Perform following –
   - How many features are there and what are their types (e.g., numeric, nominal)?
   - Compute and display summary statistics for each feature available in the dataset.(eg. minimum value, maximum value, mean, range, standard deviation, variance and percentiles
   - Data Visualization-Create a histogram for each feature in the dataset to illustrate the feature distributions. Plot each histogram.
   - Create a boxplot for each feature in the dataset. All of the boxplots should be combined into a single plot. Compare distributions and identify outliers.
2. Download Pima Indians Diabetes dataset. Use Naive Bayes‟ Algorithm for classification
   - Load the data from CSV file and split it into training and test datasets.
   - Summarize the properties in the training dataset so that we can calculate probabilities and make predictions.
   - Classify samples from a test dataset and a summarized training dataset.
3. Write a Hadoop program that counts the number of occurrences of each word in a text file.
4. Write a program that interacts with the weather database. Find the day and the station with the maximum snowfall in 2013
5. Use Movies Dataset. Write the map and reduce methods to determine the average ratings of movies. The input consists of a series of lines, each containing a movie number, user number, rating, and a timestamp: The map should emit movie number and list of rating, and reduce should return for each movie number a list of average rating.
6. Trip History Analysis: Use trip history dataset that is from a bike sharing service in the United States. The data is provided quarter-wise from 2010 (Q4) onwards. Each file has 7 columns. Predict the class of user. Sample Test data set available here https://www.capitalbikeshare.com/trip-history-data
7. Bigmart Sales Analysis: For data comprising of transaction records of a sales store. The data has 8523 rows of 12 variables. Predict the sales of a store. Sample Test data set available here https://datahack.analyticsvidhya.com/contest/practice-problem-big-mart-sales-iii/
8. Twitter Data Analysis: Use Twitter data for sentiment analysis. The dataset is 3MB in size and has 31,962 tweets. Identify the tweets which are hate tweets and which are not. Sample Test data set available here https://datahack.analyticsvidhya.com/contest/practice-problemtwitter-sentiment-analysis/
9. Time Series Analysis: Use time series and forecast traffic on a mode of transportation. Sample Test data set available here https://datahack.analyticsvidhya.com/contest/practice-problemtime-series-2/

Reference Books:

1. David Dietrich, Barry Hiller, “Data Science and Big Data Analytics”, EMC education services, Wiley publications, 2012, ISBN0-07-120413-X.
2. Ashutosh Nandeshwar , “Tableau Data Visualization Codebook”, Packt Publishing, ISBN 978-1-84968-978-6.
3. Maheshwari Anil, Rakshit, Acharya, “Data Analytics”, McGraw Hill, ISBN: 789353160258.
4. Mark Gardner, “Beginning R: The Statistical Programming Language”, Wrox Publication, ISBN: 978-1-118-16430-3
5. Luís Torgo, “Data Mining with R, Learning with Case Studies”, CRC Press, Talay and Francis Group, ISBN9781482234893
6. Carlo Vercellis, “Business Intelligence - Data Mining and Optimization for Decision Making”, Wiley Publications, ISBN: 9780470753866.

Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
418555C : LAB PRACTICE-VI (AI using R programming Lab)

Home

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Practical (PR) : 2 hrs/week	01 Credit	Term Work: 25 Oral : 50

Prerequisites: Basics of any programming language

Course Objectives:

1. To understand the basics in R programming in terms of constructs, control statements, string functions.
2. To be able to appreciate and apply the R programming from a statistical perspective.
3. To understand the concept of regression.
4. To implement Machine learning algorithms using R.

Course Outcomes:

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

CO1: Understand the use of R programming language.
CO2: Use programming structures like loops, functions, exceptions in R.
CO3: Understand the basic terminologies of statistics used in AI.
CO4: Understand the basic terminologies of probability used in AI.
CO5: To understand the concept of regression.
CO6: To implement Machine learning algorithms using R.

Guidelines for Laboratory Conduction

• List of recommended programming assignments and sample mini-projects is provided for reference. • Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses.
• Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
• Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
• Mini-project can be completed in group of 2 to 3 students.
• Software Engineering approach with proper documentation is to be strictly followed.
• Use of open source software is to be encouraged.
• Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.
• Operating System recommended: - 64-bit Open source
• Programming Languages: R
• Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net,
• Backend : MongoDB/MYSQL/Oracle,
• Database Connectivity: ODBC/JDBC, Additional Tools: Octave, Matlab, WEKA

Guidelines for Student's Lab Journal

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

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

Guidelines for Lab /TW Assessment

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

Guidelines for Practical Examination

Both internal and external examiners should jointly frame suitable problem statements for practical examination based on the term work completed.

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

List of Laboratory Assignments

Group A

1. Installing R from CRAN.
2. Installing and loading R packages
3. Write a R program to create a sequence of numbers from 20 to 50 and find the mean of numbers from 20 to 60 and sum of numbers from 51 to 91.

Group B (any 2)

1. Find the elements of a vector that are not in another vector in R
2. Find the product of vector elements in R programming language.
3. Implement linear regression using R programming
4. Implement multiple regression using r programming.

Group C (Implement any 1 application)

Mini Project:

1. Sentiment Analysis
2. Movie Recommendation System
3. Credit Card fraud detection
4. Fake news detection

Reference Books:

1. Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison-Wesley Data & Analytics Series, 2013.
2. Mark Gardener, " Beginning R – The Statistical Programming Language", Wiley, 2013
3. Robert Knell, "Introductory R: A Beginner's Guide to Data Visualisation, Statistical Analysis and Programming in R", Amazon Digital South Asia Services Inc, 2013.

Savitribai Phule Pune University, Pune Final Year Artificial Intelligence and Machine Learning (2020 Course) 418556: Project Stage-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. (AI & ML) 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

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418557A: Audit Course 8

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. Comprehend 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

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418557B: 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:

1. To understand and be aware of Cyber laws which focus on protecting the privacy of users from organizations and other users.
2. 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 the IT Act.

CO2. Understand the significance of cyber laws and their 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 the 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, Viruses, Trojans, 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 et al. Carnegiei 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. The report will be evaluated by the faculty as per rubrics defined by him/her/them at start of course.

Savitribai Phule Pune University, Pune

Final Year Artificial Intelligence and Machine Learning (2020 Course)

418557C: 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 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 of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edition, 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. The report will be evaluated by the faculty as per rubrics defined by them at start of course.