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

Home

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.