Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-411048

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Curriculum for
TY B. Tech.
(Artificial Intelligence and Data Science)
Pattern 2020

Vision

Excellence in the domain of Artificial Intelligence and Data Science for sustainable development

Mission

M1: To impart quality education with regard to existing and evolving AI & DS techniques.

M2: To groom students technologically superior and ethically strong along with research acumen.

M3: To equip students with interdisciplinary skill sets, require to cater the needs of the society.

Program Educational Objectives

PEO 1: To excel in professional career in Artificial Intelligence and Data Science Engineering and allied interdisciplinary areas.

PEO 2: To reveal strong fundamental foundation supportive for higher education and research.

PEO 3: To instill professional ethics, lifelong learning, leadership qualities and the spirit of team work beneficial towards society and environment.

Program Outcomes

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first` principles of mathematics, natural sciences and engineering sciences.

PO3. Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems:

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in

independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

At the end of program, students should be able to

- **PSO a:** Apply Data Science techniques to analyze, summarize, and comprehend data pertaining to real life.
- **PSO b:** Apply AI techniques to synthesize given problem and solving it for multi-disciplinary use cases.

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Department of Artificial Intelligence and Data Science

T.Y. B. TECH (Artificial Intelligence and Data Science)

SEMESTER V (PATTERN 2020)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme						Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW			
ADUA31201	Artificial Intelligence	TH	3	-	2	20	30	20	30	25	OR	125	4
ADUA31202	Design and Analysis of Algorithm	TH	3	-	2	20	30	20	30	25	PR	125	4
ADUA31203	Cloud Computing and Analytics	TH	3	-	2	20	30	20	30	25	TW	125	4
ES31204AD	Multivariate Analysis	TH	3	-	-	20	30	20	30	-	-	100	3
	Professional Elective #1	TH	3	-	2	20	30	20	30	25	OR	125	4
ADUA31206	Design Project I	CE	1	-	2	-	-	-	-	25	TW	25	2
	Mandatory Course on Indian Constitution	AU	-	-	-	-	-	-	-	-		-	-
	Total		16	0	10	100	150	100	150	125		625	21

BOS Chairman **Dean Academics** **Director**

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Department of Artificial Intelligence and Data Science

T.Y. B. TECH (Artificial Intelligence and Data Science)

SEMESTER VI (PATTERN 2020)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme						Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW			
ADUA32201	Machine Learning	TH	3	-	2	20	30	20	30	25	PR	125	4
ADUA32202	Data Science	TH	3	-	2	20	30	20	30	25	OR	125	4
ADUA32203	Natural Language Processing	TH	3	-	2	20	30	20	30	25	TW	125	4
	Professional Elective #2	TH	3	-	2	20	30	20	30	25	OR	125	4
IOEUA32205F	XAI for Engineering	TH	3	-	-	20	30	20	30	-		100	3
ADUA32206	Design Project-II	CE	1	-	2	-	-	-	-	25	TW	25	2
	Mandatory Course-Indian Constitution	AU	-	-	-	-	-	-	-	-		-	-
	Total		16	0	10	100	150	100	150	125		625	21

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Department of Artificial Intelligence and Data Science

List of Professional Electives

Domain	Semester – V		Semester – VI	
	Elective – I		Elective – II	
	Subject Code	Subject Name	Subject Code	Subject Name
Advance Network Technologies	ADUA31205(A)	Cyber Security	ADUA32204(A)	Internet of Things
Image Intelligence	ADUA31205(B)	Image Processing	ADUA32204(B)	Augmented Reality Virtual Reality
Contemporary Technologies	ADUA31205(C)	Information storage and retrieval	ADUA32204(C)	Fundamentals of Blockchain technology

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SEMESTER-V

Bansilal Ramnath Agarwal Charitable Trust's
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Department of Artificial Intelligence and Data Science

ADUA31201: Artificial Intelligence

Teaching Scheme	**Examination Scheme**
Credits: 4	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: 2 Hrs/week	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks
	OR: 25 Marks

Prerequisites:

- Linear algebra and Calculus
- Fundamental of Probability and Statistics
- Problem Solving and Data Structures.

Course Objectives:

- Learn the concept of Artificial Intelligence
- Acquire problem solving approaches using Artificial Intelligence
- Familiarize the concept of Expert Systems and machine learning

Course Outcomes:

After completion of the course, student will be able to

1. Get acquainted with AI techniques
2. Identify problem formulation and problem-solving techniques
3. Learn Heuristic Search to find solution in proper time
4. Optimize mathematical problems in AI
5. Absorb Knowledge based on Fuzzy techniques.
6. Apply the planning techniques and machine learning strategies

Unit I:	Introduction to Artificial Intelligence	6 Hrs

Introduction, AI Applications, Intelligent agents, Types of agents, Environment and its types: accessible Vs inaccessible, deterministic Vs non-deterministic, Episodic Vs Sequential, Discrete Vs Continuous, Static Vs Dynamic, Single agent Vs Multi agent Case

Case Studies: Nought and Crosses.

Unit II:	Problem Solving Agent	6 Hrs

Goal Formulation, Problem Formulation, Single state problem, multiple state problem, Contingency problem, exploration problem, Search for solution, Execution of solution.

Case Studies: Vacuum Cleaner Problem, Water Jug Problem

Unit III:	Heuristic Searches	6 Hrs

Heuristic Search techniques in AI: Direct Heuristic Search Techniques, Weak Heuristics Search Techniques. Constraint Satisfaction Problem (CSP), Simulated Annealing Heuristic Search: Breadth First Search (BFS) Heuristic Search.

Case Studies: Travelling Salesperson: Nearest Neighbor Heuristic, Reversal Heuristic.		
Unit IV:	**Hill Climbing in AI**	**6 Hrs**
Features of Hill Climbing in AI, Types of Hill Climbing in AI: Simple Hill Climbing, Steepest Ascent Hill Climbing, Stochastic Hill Climbing. Problems with Hill Climbing in AI: Local Maximum, Plateau, Ridge. **Case Studies:** Travelling salesperson using Hill Climbing		
Unit V:	**Knowledge building from Inference**	**6 Hrs**
Different types of knowledge, Knowledge representation in AI, Relation between knowledge and Intelligence, Techniques of Knowledge representation in AI, Properties to good knowledge representation, approaches to represent Knowledge in AI, Production Based System: Characteristics of Production System, Classes of Production System. Knowledge Inference: Inference rules, Forward and Backward Chaining. Fuzzy reasoning, Bayesian Network, Dempster Shafer Theory (DST) **Case Studies:** An Expert System for diagnosis of Blood disorder		
Unit VI:	**Planning Techniques and Machine Learning strategies**	**6 Hrs**
Basic Plan Generation Systems: Components of Planning System, Block World Problem. Strips, Goal Stack Algorithm, Machine Learning: Components of learning System, Performance element, Learning element, critic, Problem Generator. Learning Paradigm: Rote learning, Induction, Clustering, Analogy, Discovery, Genetic algorithm, Reinforcement learning, Adaptive Learning. **Case Studies:** Missionaries and Cannibals, Four people on a Rickety Bridge.		
Text Books:		
1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)"", Mc Graw Hill-2008 2. Dan W. Patterson," Introduction to AI and ES", Pearson Education, 2007. 3. Parag Kulkarni, Prachi Joshi, " Artificial Intelligence building intelligent systems", PHI.		
Reference Books:		
1. Stuart Russel and Peter Norvig "AI – A Modern Approach ", 2nd Edition, Pearson Education 2007 2. Deepak Khemani "Artificial Intelligence", Tat Mc Graw Hill Education 2013		
Online resources:		
1. https://nptel.ac.in/courses/106105077 2. https://onlinecourses.nptel.ac.in/noc21_cs42/preview		

List of Assignments: (Python)

1	Write a program for Automatic Nought and Crosses using random number
2	Two jugs are having capacity 4 and 3 respectively. Both the jugs do not have markings on them to measure smaller quantities. Measure 2 litres of water using the two jugs
3	Given an input n, print a n X n matrix consisting of numbers form 1 to n each appearing exactly once in each row and each column (Constraint satisfaction problem)
4	Write a program to implement breadth first search (Heuristic search).
5	Write a program to apply simulated annealing algorithm to a simple 1-D x^2 objective function with the bounds [-5,5]
6	A salesperson visits a number of cities exactly once and return to the first city, find the shortest route (Hill Climbing)

7	In a competition in which a contestant must choose one of three doors, one of which conceals a price. The show's host unlocks an empty door and asks the contestant if he wants to swap to the other door after the contestant has chosen one. The decision is whether to keep the current door or replace it with a new one. It is preferable to enter by the other door because the price is more likely to be higher. Write a program to come out from this ambiguity. (Inferencing using Bayesian network).
8	Write a program which uses Q-values to iteratively improve the behaviour of learning agent (Reinforcement learning)

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ADUA31202: Design and Analysis of Algorithm

Teaching Scheme	**Examination Scheme**
Credits: 4	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: 2 Hrs/week	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks
	PR: 25 Marks

Prerequisites:

- Discrete Mathematics
- Data Structure
- Advance Data Structure

Course Objectives:

- To develop problem solving abilities using mathematical theories;
- To learn algorithmic strategies while solving problems
- To design time and space efficient algorithms;
- To study algorithmic computational complexities and parallel algorithms.

Course Outcomes:

After completion of the course, student will be able to

1. To calculate computational complexity using asymptotic notations for various algorithms.
2. To apply Divide & Conquer as well as Greedy approach to design algorithms.
3. To practice dynamic programming approach
4. To illustrate application of Backtracking for real world applications.
5. To compare different methods of Branch and Bound strategy.
6. To explore the concept of P, NP, NP-complete, NP-Hard and parallel algorithms.

Unit I:	Introduction to Analysis of Algorithm	5 Hrs

Time analysis of basic programming constructs, Time and space complexity trade off,
Analysis of Algorithm: Efficiency- Analysis framework, asymptotic notations – big O, theta and omega. Lower bound and upper bound,
Amortized Analysis: Aggregate, Accounting & Potential method with the example of stack operations.
Analysis of Non-recursive and recursive algorithms: Solving Recurrence Equations (Homogeneous and non-homogeneous). Overview of algorithmic strategies.
Case Studies: Perform Analysis of Non-recursive and recursive algorithms algorithm

Unit II:	Divide and Conquer and Greedy Method	7 Hrs

Divide & Conquer: General method, Control abstraction, time analysis of Divide and Conquer analysis with recurrence, Merge sort, Quick Sort – Worst, Best and average case. Binary Search, Finding Max-Min, Large integer Multiplication (for all above algorithms analysis to be done with recurrence).
Greedy Method: General method and characteristics, Principle, control abstraction, time analysis of control abstraction, Fractional Knapsack problem, scheduling algorithms-Job scheduling and activity selection problem.
Case Studies: Design Sorting algorithm using Divide and Conquer, also develop solution for problems using Greedy Method.

Unit III:	Dynamic programming	6 Hrs
General strategy, Dynamic programming for optimization problems, Principle of optimality, Multistage graphs, Optimal Binary Search Tree, Single source shortest path, All-pairs shortest path, 0/1 Knapsack problem, Traveling Sales person problem. **Case Studies:** Develop algorithms for find the distance between districts of Maharashtra state using Dynamic programming.		
Unit IV:	**Backtracking**	**6 Hrs**
General method, Recursive backtracking algorithm, Iterative backtracking method. N-Queen problem, Sum of subsets, Graph colouring, Hamiltonian Cycle, 0/1 Knapsack Problem. **Case Studies:** Design algorithm using Backtracking for solution of 0/1 Knapsack problem		
Unit V:	**Branch and bound**	**6 Hrs**
The method, Control abstractions for Least Cost Search, Bounding, FIFO branch and bound, LC branch and bound, 0/1 Knapsack problem – LC branch and bound and FIFO branch and bound solution, Traveling sales person problem. **Case Studies:** Apply LC search for solving the problems and perform analysis		
Unit VI:	**Computational complexity and parallel algorithms**	**6 Hrs**
Computational Complexity: Deterministic and Non-Deterministic algorithms, The classes: P, NP, NP Complete, NP Hard, Satisfiability problem, Proofs for NP Complete Problems: Clique, Vertex Cover. Parallel Algorithms: Introduction, models for parallel computing, computing with complete binary tree, Pointer doubling algorithm, Optimize parallel algorithms. **Case Studies:** Understand non deterministic algorithm and solve NP Complete problem.		

Text Books:

1. Horowitz and Sahani, Fundamentals of computer Algorithms, Galgotia, ISBN 81-7371-612-9.
2. Thomas H Cormen and Charles E.L Leiserson, Introduction to Algorithm, PHI, ISBN:81-203-2141-3.

Reference Books:

1. S. Sridhar, Design and Analysis of Algorithms, Oxford, ISBN 10 : 0-19-809369-1.
2. Anany Levitin, Introduction to the Design & Analysis of Algorithm, Pearson, ISBN 81- 7758-835-4.

List of Assignments:

1	Write a program to perform binary search on an unsorted random list of at least 5000 elements. The key element should be user input. Use the Divide & Conquer method to implement this program.
2	Implementation the following algorithm using Divide & Conquer method. (a)Merge sort (b) Quick Sort Also display execution time for different size of input and perform the analysis.
3	Solve the following instance of the knapsack problem given the knapsack capacity in w=20 using greedy methods. Total no of item is 5.

Item	Weight	Profit
X_1	3	10
X	5	20
X_1	5	21
X_1	8	30

	X_1	4	16	
4	Implement All Pair Shortest paths problem using Floyd's Algorithm.			
5	Implement 0/1 Knapsack problem using Following algorithmic strategies. (a) Dynamic programming (b) Back tracking (C) Branch and bound			
6	Implement N- queen Problem using Back tracking method. A suitable message is to be displayed if the given Problem instance doesn't have a solution.			
7	Find a subset of a given set S = {s1 ,s2 ,.....,s n } of n positive integers whose sum is equal to a given positive integer d. For example, if S= {1, 2, 5, 6, 8} and d = 9 there are two solutions {1,2,6} and {1,8}. A suitable message is to be displayed if the given Problem instance doesn't have a solution.			
8	Implement any scheme to find the optimal solution for the Traveling Salesperson problem and then solve the same problem instance using different algorithmic strategies and determine the optimal solution.			

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Department of Artificial Intelligence and Data Science

ADUA31203: Cloud Computing & Analytics

Teaching Scheme	**Examination Scheme**
Credits: 4	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: 2 Hrs/week	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks
	TW: 25 Marks

Prerequisites:

- Fundamental of Computer Network

Course Objectives:

- Explore Storage and Services of cloud infrastructure.
- Understand layers and cloud platform for various services.
- Manage and secure the cloud for risk.

Course Outcomes:

After completion of the course, student will be able to

1. Understand fundamental of cloud computing infrastructure.
2. Study cloud architecture and services for solution of business and scientific problems.
3. Make familiar on various cloud platform
4. Apply knowledge for identity management the cloud
5. Awareness of security features for cloud
6. Demonstrate various applications of cloud services.

Unit I:	Fundamentals of Cloud Computing	6 Hrs

Cloud Computing Basics – History of Cloud Computing, Need for Cloud computing, Architecture of cloud Computing, Characteristics of Cloud Computing, Advantages and Disadvantages of cloud computing, Cloud Service Providers, Cloud Deployment Models – Public, Private, Hybrid, Cloud Security, Cloud Scalability, Time to Market.

Case Studies: Develop study on features of cloud platform.

Unit II:	Cloud Architecture- Layers and Delivery Models	6 Hrs

Layers in cloud architecture, Introduction to Cloud Services, Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as Service (SaaS) – Overview, Virtualization and its benefits, Service Level Agreements and violation, Migrating to the Cloud, Virtual Private Cloud (VPC), Storage and Security in cloud.

Case Studies: Analysis of various services on Google cloud/ AWS.

Unit III:	Cloud Platforms	6 Hrs

Cloud Platforms, Evaluating cloud platforms, Cloud Platform technologies Amazon Web Services, Microsoft Azure, Google Cloud Platform, Salesforce, Impact of Cloud platforms. Private Cloud Platforms – Introducing Private clouds – Microsoft Azure stack, Open stack, Impact of Private clouds.

Case Studies: Compare and study cloud platforms (AWS/Google/ Microsoft)

Unit IV:	Managing the Cloud	6 Hrs

Managing and Securing Cloud Services, Virtualization and the Cloud, Managing Desktops and devices on the cloud, SOA and Cloud computing, Managing the Cloud environment, planning for the Cloud – Economic Cost Model and Leveraging the Cloud, Cloud computing resources, Cloud Do and Don'ts.

Case Studies: Develop case studies on manage the cloud services and planning.		
Unit V:	**Security in the Cloud**	**6 Hrs**
Understanding Security and Risk, Key Principles of Information Security, Risk Management Basics, Reviewing Security Standards, Exploring Common Security Risks and Mitigations, Application Interface, Shared Technology, Insider and Criminal Threats, Data Exposure and Loss, Organizational Risks, Implementing an ISMS, Responding to Incidents, Digital Forensics in the Cloud, Recognizing Security Benefits. **Case Studies:** Explore Common Security Risks and Mitigations		
Unit VI:	**Applications in the Cloud**	**6 Hrs**
Understanding the Role of Standard Applications, Desktop Applications, Distributed Applications, Web-Based Applications, Cloud Applications, Developing Cloud-Ready Applications, Cloud-Ready Application Patterns, Cloud-Ready Application Development, Docker-Docker desktop, docker Hub Migrating Applications to the Cloud, Preparing for Technical Challenges, Identifying and Mitigating Risks. **Case studies:** Develop any application and deploy on cloud.		
Text Books:		
1. Mastering Cloud Computing Foundations and Applications Programming" by Rajkumar Buyya 2. Enterprise Cloud Computing - Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press, 2010		
Reference Books:		
1. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley – India, 2010		
Online resources:		
1. https://onlinecourses.nptel.ac.in/noc22_cs20/preview 2. www.openstack.org		

List of Assignments:

1	Study of Cloud Computing & Architecture
2	Study and implementation of Infrastructure as a Service
3	Study and installation of Storage as Services on cloud
4	Implementation of identity management.
5	To create and access VM instances and demonstrate various
6	Case study on Amazon EC2/ Microsoft Azure.
7	To create and access VM instances and demonstrate various components such as EC2, S3, Simple DB, DynamoDB. Technology: AWS
8	Deploy web applications on commercial cloud. Technology: Google appEngine/ Windows Azure 2
9	Study and explore – case study with devops and site reliability engineering

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Department of Artificial Intelligence and Data Science

ES31204AD: Multivariate Analysis

Teaching Scheme	Examination Scheme
Credits: 3	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: -	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks

Prerequisites:

- Linear Algebra
- Fundamental of Probability and Statistics
- Calculus

Course Objectives:

- To understand the features of multivariate data.
- To apply Multivariate normal distribution and Inferential Statistics
- To carry out multivariate statistical techniques and methods efficiently and effectively

Course Outcomes:

After completion of the course, student will be able to

1. To understand fundamental of Multivariate statistical modelling
2. To study sample geometry of multivariate data point and random sampling.
3. To explore the concept of multivariate distribution of data points.
4. To perform Multivariate Analysis of Variance on data point or observations.
5. Apply multivariate technique to develop the model
6. To compare different Factors on multivariant data points.

Unit I:	Introduction	6 Hrs

Introduction to Multivariate statistical modelling, need of Multivariate statistics, data types, different model and basic steps, statistical approaches to model building, Univariate & Multivariate descriptive statistics

Case Studies: Descriptive statistics for dataset, use of matplotlib for EDA

Unit II:	Sample Geometry and Random Sampling	6 Hrs

The Geometry of the Sample. Random Samples and the Expected Values of the Sample Mean and Covariance Matrix. Generalized Variance. Sample Mean, Covariance, and Correlation as Matrix Operations. Sample Values of Linear Combinations of Variables.

Case Studies: Calculate sample Mean, Covariance, and Correlation as Matrix Operations

Unit III:	Multivariate Distribution	6 Hrs

Notions of Multivariate Distribution and data tendency, The Multivariate Normal Distribution, The Distribution of Linear Combinations of Normally I Distributed Variates; Independence of Variates; Marginal Distributions, Conditional Distributions and Multiple Correlation Coefficient.

Case Studies: Design and develop model using multivariate distribution

Unit IV:	Multivariate Inferential Statistics	6 Hrs

Elementary Properties of the Multinormal, The Wishart Distribution, Hotelling T2 distribution, Confidence region, Simultaneous confidence interval: Bonferroni approach

Hypothesis testing: Single population mean vector; two population mean vectors. Multivariate Analysis of Variance: Basics of MANOVA, Differences between ANOVA and MANOVA, Hypothesis testing in MANOVA Parameters **Case Studies:** Draw Conclusion on Multivariate Inferential Statistics		
Unit V:	**Multivariate Techniques**	**6 Hrs**
Decomposition of Data Matrices by Factors, Principal components analysis, Factor analysis, Cluster Analysis: Proximity between Objects, Multidimensional Scaling: Metric and non-metric Multidimensional Scaling **Case Studies:** Develop applications using Multivariate Techniques		
Unit VI:	**Factor Analysis and Inference for Structured Covariance Matrices**	**6 Hrs**
The Orthogonal Factor Model. Methods of Estimation. Factor Rotation. Factor Scores. Perspectives and a Strategy for Factor Analysis. Structural Equation Models. Supplement 9A Some Computational Details for Maximum Likelihood Estimation. **Case Studies:** Maximum Likelihood Estimation on products/ stuffs		
Text Books:		
1. Applied multivariate statistical analysis by R A Johnson and D W Wichern, Sixth Edition, PHI, 2012 2. Multivariate data analysis by Joseph F. Hair Jr, Rolph E. Anderson, Ronald L Tatham, and William C. Black, Fifth Edition, Pearson Education, 1998.		
Reference Books:		
1. Applied multivariate analysis by N H Timm, Springer, 2002.		
Online resources:		
1. NPTEL : https://onlinecourses.nptel.ac.in/noc22_ma09/course 2. Applied Multivariate Statistical Analysis: https://online.stat.psu.edu/statprogram/stat505		

List of Assignments:

1 Write R code to find the correlation matrix and covariance matrix of the data in Table 1.1.

Table 1.1: `hypo` data. Hypothetical Set of Multivariate Data.

individual	sex	age	IQ	depression	health	weight
1	Male	21	120	Yes	Very good	150
2	Male	43	NA	No	Very good	160
3	Male	22	135	No	Average	135
4	Male	86	150	No	Very poor	140
5	Male	60	92	Yes	Good	110
6	Female	16	130	Yes	Good	110
7	Female	NA	150	Yes	Very good	120
8	Female	43	NA	Yes	Average	120
9	Female	22	84	No	Average	105
10	Female	80	70	No	Good	100

2 Write R code to Convert the covariance matrix given below into the corresponding correlation matrix.

<table>
<tr><td></td><td>$$\begin{pmatrix} 3.8778 & 2.8110 & 3.1480 & 3.5062 \\ 2.8110 & 2.1210 & 2.2669 & 2.5690 \\ 3.1480 & 2.2669 & 2.6550 & 2.8341 \\ 3.5062 & 2.5690 & 2.8341 & 3.2352 \end{pmatrix}.$$</td></tr>
<tr><td>3</td><td>To study different Multivariate Statistical Tools and Techniques.</td></tr>
<tr><td>4</td><td>The following ten bivariate random observations were collected from a population.
<table>
<tr><td>X1</td><td>50</td><td>56</td><td>43</td><td>53</td><td>51</td><td>46</td><td>49</td><td>51</td><td>61</td><td>60</td></tr>
<tr><td>X2</td><td>20</td><td>28</td><td>28</td><td>25</td><td>30</td><td>37</td><td>27</td><td>31</td><td>26</td><td>30</td></tr>
</table>
Find the inverse of S (where S is a sample covariance matrix).</td></tr>
<tr><td>5</td><td>A doctor has collected data on cholesterol, blood pressure, and weight. She also collected data on the eating habits of the subjects (e.g., how many ounces of red meat, fish, dairy products, and chocolate consumed per week). She wants to investigate the relationship between the three measures of health and eating habits.</td></tr>
<tr><td>6</td><td>Design a model to predict the housing price from Boston Dataset using Multivariate Linear Regression.</td></tr>
<tr><td>7</td><td>Build a classifier using Logistic Regression, k- Nearest Neighbour / Decision Tree to classify whether the given user will purchase a product or not from a social networking dataset.</td></tr>
<tr><td>8</td><td>Apply the factor analysis model separately to the life expectancies of men and women and compare the results.</td></tr>
<tr><td>9</td><td>Dimensionality reduction of any CSV/image dataset using Principal Component Analysis</td></tr>
<tr><td>10</td><td>Segment a customer dataset based on the buying behaviour of customers using K-means/Hierarchical clustering.</td></tr>
</table>

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ADUA31205(A): Cyber Security

Teaching Scheme	**Examination Scheme**
Credits: 4	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: 2 Hrs/week	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks
	OR: 25 Marks

Prerequisites:

- Fundamentals of Computers and Programming
- Discrete Mathematics
- Fundamental of Computer Networks

Course Objectives:

- Making students familiar with the central concepts of information and cyber security
- Making students familiarize with major security risks, threat analysis and attack vectors
- Providing tools and practices for design and building security solutions

Course Outcomes:

After completion of the course, student will be able to

1. Learn the fundamental concepts of network and information security in the context of cyber world
2. Compare merits and demerits of different cryptographic techniques/protocols and take decisions while securing a network.
3. Provide security in the computer applications and networks using mathematical and cryptographic functions
4. Performs threat analysis and attack modelling of the known attacks for the purpose of mitigation
5. Apply the knowledge for drafting clear security goals to build end-to-end security concept
6. Learn and apply knowledge for application and protocol development in information and cyber security

Unit I:	Introduction to Security	6 Hrs

Computer Security Concepts, Cyber Security, Information and Network Security, Security Trends, the OSI Security Architecture, Security Attacks, Security Features, Security Mechanisms, A Model for Network Security, Cryptography and steganography, Cryptosystems

Case Studies: Phishing, Ransomware, Supply Chain Attacks

Unit II:	Symmetric Ciphers	6 Hrs

Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Block Ciphers and the Data Encryption Standard, Block Cipher Principles, The Data Encryption Standard (DES), Multiple Encryption and Triple DES, The Strength of DES, Advanced Encryption Standard, AES Structure, Round Functions, AES Key Expansion, Stream Ciphers, RC4

Case Studies: **Banking Sector, Data at rest**

Unit III:	Asymmetric Ciphers	6 Hrs

Number Theory, Prime Numbers, Fermat's and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem, Discrete Logarithms, Public-Key Cryptography and RSA, Principles of Public-Key Cryptosystems, The RSA Algorithm, Diffie-Hellman Key Exchange, ElGamal Cryptosystem, Elliptic Curve Cryptography

Case Studies: Messaging applications, HTTPS		
Unit IV:	**Cryptographic Hash Functions**	**6 Hrs**
Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Requirements and Security, Hash Functions Based on Cipher Block Chaining, Message Digest 5, Secure Hash Algorithm (SHA), SHA-3, Digital Signatures **Case Studies:** PGP, HMAC		
Unit V:	**Key Management Techniques**	**6 Hrs**
Digital Signatures, Public-Key Certificates PKI, PKIX, and X.509, CA Hierarchy, User Authentication Protocols Public-Key Certificates PKI, PKIX, and X.509, CA Hierarchy Comparison of key management in Symmetric and Asymmetric cryptosystems, Quantum key cryptography, key Management and distribution **Case Studies:** KDC, Key Management in Wireless Networks		
Unit VI:	**Cyber Security and Malicious Software**	**6 Hrs**
Intruders, Intrusion Detection and Prevention, Password Management, Malicious Software, Types of Malicious Software, Viruses, Virus Countermeasures, Worms, Distributed Denial of Service Attacks, Code Security, Cloud Security, IoT security, Digital cash, Machine Learning for Cyber security. **Case Studies:** Blockchain, AI in Security		
Text Books:		
1. William Stallings, "Cryptography and Network Security: Principles and Practice," 6th Edition, Pearson.		
Reference Books:		
1. Forouzan and Mukhopadhyay, "Cryptography and Network Security", McGraw Hill, 2nd Edition. 2. Atul Kahate, "Cryptography and Network Security", McGraw Hill, 2nd Edition.		
Online resources:		
1. https://onlinecourses.nptel.ac.in/noc21_cs16/preview		

List of Assignments:

1	Compare and contrast substitution and transposition techniques and implement any two Methods. (Caesar cipher, Playfair cipher, Hill cipher, Vigenere cipher, Rail fence - row and column transformation)
2	Study and explore Cryptool and AVISPA tool.
3	Compare symmetric and asymmetric key cryptosystem by referring to the appropriate use case with respect to the applicability and implement two algorithms of each type.
3	Design and implement digital Signature Scheme.
4	Study and demonstrate Intrusion Detection system with the help of appropriate tool and decide the design methodology for smart intrusion prevention system.
5	Perform threat analysis and attack modelling any E-commerce / M- commerce service or application.
6	Install and configure any web browser and explore various security settings at each OSI layer with small use cases.
7	Study Assignment 1. Wired or Wireless Network as a case study 2. Firewall study and configuration

	3. Website hacking
8	Implementation of Mini Project on Cyber Security.

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ADUA31205(B): Image Processing

Teaching Scheme	Examination Scheme
Credits: 4	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: 2 Hrs/week	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks
	OR: 25 Marks

Prerequisites:

- Linear algebra and Calculus
- Fundamental of Probability and Statistics
- Basic Programming Skills

Course Objectives:

- Impart fundamental knowledge and technical competence in field of Image Processing
- Build foundation for various image processing techniques
- Introduction of AI application to the field of Image Processing

Course Outcomes:

After completion of the course, student will be able to

1. Understand image model and explain techniques for image enhancement
2. Process colour image using various techniques
3. Apply segmentation techniques
4. Apply various techniques to restore and reconstruct an image
5. Process an image morphologically
6. Apply basics of AI for image processing

Unit I:	Fundamentals of Image Processing & Image Enhancement	6 Hrs

Digital Image Processing: Introduction, Applications, Fundamental Steps, Components of an Image Processing System, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels.

Image Enhancement: Background, Some Basic Intensity Transformations, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters

Case Study: Enhancement of Satellite Images

Unit II:	Color Image Processing	6 Hrs

Color Fundamentals, Color Models, Pseudocolor Image Processing, Basics of Full-Color Image Processing, Color Transformations, Smoothing and Sharpening, Image Segmentation based on color, Noise in color images

Case Study: Color segmentation applications

Unit III:	Image Restoration and Reconstruction	6 Hrs

Introduction to restoration and Reconstruction, Noise Models, Restoration in the Presence of Noise Only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Image Reconstruction from Projections

Case Study: Restoration and reconstruction of Historical Devanagari Manuscripts

Unit IV:	Image Compression	6 Hrs
Fundamentals: Coding Redundancy, Spatial and Temporal Redundancy, Irrelevant Information, Fidelity Criteria, Measuring Image Information, Image Compression Models, Image Formats, Containers, and Compression Standards **Some Basic Compression Methods:** Huffman Coding, Golomb Coding, Arithmetic Coding, LZW Coding, Run-Length Coding, Symbol-Based Coding **Case Study:** Image compression using Bandlets, Contourlets		
Unit V:	**Morphological Image Processing & Segmentation**	**6 Hrs**
Morphological Image Processing: Preliminaries, Erosion and Dilation, opening & closing operations, basic morphological operations such as region filling, thinning, thickening, skeletons, pruning for binary images. **Image Segmentation:** Fundamentals, Point, line and edge detection, region-based segmentation **Case Study:** Applications of morphological image processing in the domain of forensic, metrology etc. Medical Image Segmentation and it's Applications		
Unit VI:	**Application of Neural Network for Object Detection**	**6 Hrs**
Patterns and Pattern Classes, Recognition Based on Decision-Theoretic Methods: Matching Optimum Statistical Classifiers, Neural Networks, Structural Methods: Matching Shape Numbers, String Matching **Case Study:** Suspicious Object Detection		

Text Books:

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 2nd Edition, 2002, ISBN: 9780201180756, Prentice Hall.
2. Jayaraman S, "Digital Image Processing", 1st Edition, 2009, ISBN: 9780070144798, TMH (McGraw Hill Education) publication

Reference Books:

1. Fundamentals of Digital Image Processing, Jain A.K., PHI, 1997
2. Image Processing, Analysis & Machine Vision, Milan Sonka, Thomson Publication
3. Hands-On Image Processing with Python: Expert techniques for advanced image analysis and effective interpretation of image data, Sandipan Dey, Packt Publication

Online resources:

1. Digital Image Processing Lecture Series
   https://www.youtube.com/watch?v=sa7vO6YXBik&list=PL3rE2jS8zxAykFjinlf6EsucLv5EA03_m&index=1
2. Introductory python tutorials for image processing
   https://www.youtube.com/watch?v=7uE6hypji0o&list=PLHae9ggVvqPgyRQQOtENr6hK0m1UquGaG
3. Hands-On-Image-Processing-with-Python
   https://github.com/PacktPublishing/Hands-On-Image-Processing-with-Python

List of Assignments:

Perform practical assignments based on (but not limited to) following problem statements

1	Set up different image processing libraries in Python. Perform basic image manipulations (resizing, cropping, negating) and transformations (linear, affine transformations)
2	Perform linear and non-linear noise smoothing for a noisy image.

3	Perform histogram equalization and matching.
4	Perform edge detection from an image using derivatives and filters.
5	Perform various morphological operations on an image. (Erosion, Dilation, skeletonizing, removing small objects, extracting boundaries etc.)
6	Perform edge based and region-based segmentation
7	Perform image compression using any basic algorithm (e.g., Huffman coding, run length coding, symbol based encoding)
8	Perform object detection from an image

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ADUA31205(C): Information Storage and Retrieval

Teaching Scheme	**Examination Scheme**
Credits: 4	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: 2 Hrs/week	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks
	OR: 25 Marks

Prerequisites:

- Data structures
- DBMS
- Probabilities and statistics

Course Objectives:

- To introduce the need of Information Storage and Retrieval (ISR) systems
- To understand the components and functions of Information Retrieval (IR) systems
- To recognize the methods and models in IR systems

Course Outcomes:

After completion of the course, student will be able to

1. Demonstrate the need of IR systems
2. Understand and identify components of retrieval system
3. Identify and apply retrieval model to real time examples
4. Use the evaluation metrics to measure performance of the retrieved information
5. Demonstrate the use of feedback in information retrieval
6. Apply various techniques to solve IR problems

Unit I:	Introduction to Retrieval systems	4 Hrs

Introduction to IR, knowledge base, expert system, Notion of Relevance, IR problems, Conceptual Models, Basics of Information Storage and Retrieval: Key concepts of ISR, Components of an ISR system, Types of ISR systems, traditional systems, retrieval vs mining

Case studies: Digital libraries

Unit II:	Data, information and Storage	6 Hrs

Information representation, structure of data, file structure, organisational methods, parsing data elements, pre-processing techniques, combination structures, indexing techniques, compression & disk storage

Type of documents, document surrogates, vocabulary control, structure of a thesaurus, structural representation, fine data structure, bit and byte, MARC structures

Case studies: indexing a document corpus

Unit III:	Information Retrieval models	8 Hrs

Architecture of search engine, Query Logic, functions, interpretation and execution of statements, query processing models, probabilistic models, language models, extended boolean models, query space models, term weighting, Associations, Data fusion, extended user profile, current awareness systems, retrospective search systems, reference point, modifying the query by the input

Case studies: XML retrieval

Unit IV:	Evaluation, presentation and visualization	6 Hrs
Measures for relevancy: Precision, recall, fallout, generality, Coverage ratio, novelty ratio, relative recall, recall effort, Average & normalized precision and recall, expected search length, Sliding ratio, Satisfaction and frustration Ranking, clustering, output exploration, visual interfaces for output exploration like SOM. Text classification – KNN, Page rank **Case studies:** Model evaluation and visualization on search queries		
Unit V:	**Feedback**	**6 Hrs**
Relevance Feedback, Rocchio feedback, and other feedback methods, relevance models, estimating relevance models, effectiveness, user reactions, profiles, adaptive information retrieval **Case studies:** User profiling & profile translation using search history		
Unit VI:	**Advancements in IR**	**6 Hrs**
Multimedia IR, Web crawling, Parallel and distributed IR, semantic web, conversation AI, Web scraping, Context based retrieval **Case studies:** Legal information retrieval from research papers		

Text Books:

1. Introduction to Information Retrieval, Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Cambridge University Press, 2008. ISBN-10: 0521865719
2. Modern Information Retrieval: The Concepts and Technology behind Search (2nd Edition), Ricardo Baeza-Yates and Berthier Ribeiro-Neto
   ACM Press Books, 2011. ISBN-10: 0321416910
3. Statistical Language Models for Information Retrieval by Cheng Xiang Zhai

Reference Books:

1. Charles T. Meadow, Bert R. Boyce, Donald H. Kraft, and Carol L. Barry. 2007. Text Information Retrieval Systems, Third Edition, Academic Press, Inc., USA, ISBN:978-0-12-369412-6
2. Search Engines: Information Retrieval in Practice by W. Bruce Croft, Donald Metzler, and Trevor Strohman

Online resources:

1. https://nlp.stanford.edu/IR-book/information-retrieval.html

List of Assignments:

1	Study the various ways in which information is available. Analyse the ways in which the information can be represented.
2	Write a code to parse pages/ documents on any online information displaying site. Generate an output of text statistics.
3	From a given set documents of resumes, write a code to retrieve email ids.
4	Apply indexing technique to create a document index file for above example.
5	Create document corpus of assignments. Use Probabilistic model to determine the relevant documents.
6	Use evaluation metrics to determine the various factors impacting the retrieval process in assignment 5.
7	With an example show the application of Feedback mechanism (any one)

	Show how the satisfaction and frustration evaluations.
8	Summarise a research paper based on relevant keywords

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ADUA31206: Design Project I

Teaching Scheme	**Examination Scheme**
Credits: 2	TW: 25 Marks
Lectures: 1 Hrs/week	
Practical: 2 Hrs/week	

Prerequisites:

- Software Engineering

Course Objectives:

- To understand the concepts and applicability of design thinking
- To familiarize students with innovation

Course Outcomes:

After completion of the course, student will be able to

1. Develop humancentric mindset for innovation and design
2. Describe and demonstrate skills to apply principles of innovation and idea generation
3. Apply design thinking for product innovation

Unit I:	Introduction to design thinking in engineering	3 Hrs

Introduction, Need of Design Thinking, Traditional Problem Solving versus Design Thinking, Phases of Design Thinking, Tools for Design Thinking, Relevance of Design and Design Thinking in Engineering, Challenges best suited for design thinking, Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations.

Unit II:	Introduction to innovation	3 Hrs

Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations, Teams for innovation, Measuring the impact and value of creativity, design inspired innovation and user innovation

Unit III:	Product design	3 Hrs

Product Design: problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications, New Product Development Processes, Design for Products & Services, Sustainability through Design Thinking, human factors in design and innovation, cognitive and emotional aspects, case study – Jaipur foot, smart cane for blind

Unit IV:	Innovation & Entrepreneurship	3 Hrs

Idea generation process, Innovation Management & Entrepreneurship, Innovation Project Life-cycle, Innovation Management Models, Frugal Innovation, Entrepreneurship Vs Intrapreneurship, Concept generation, prototyping, evaluation.

Text Books:

1. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press , 2009
2. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011
3. John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design",Cengage

learning (International edition) Second Edition, 2013.
4. Design Thinking for Beginners: Innovation as a factor for entrepreneurial success Hardcover by Kilian Langenfeld

Reference Books:

1. Product Design and Manufacturing by A.K. Chitale and R.C. Gupta, Prentice Hall
2. Universal principles of design- William Lidwell, Kritina holden, Jill butter.

Online resources:

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-033-computer-system-engineering-spring-2018/design-project/
2. https://archive.nptel.ac.in/courses/107/103/107103082/

List of Assignments:

Assignments to be based on surveys to understand the user problems, innovation of new technology or product/ upgrading existing product, creativity with design thinking, prototype building, sustainability and feasibility exploration in the new design.

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SEMESTER-VI

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Department of Artificial Intelligence and Data Science

ADUA32201: Machine Learning

Teaching Scheme	**Examination Scheme**
Credits: 4	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: 2 Hrs/week	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks
	PR: 25 Marks

Prerequisites:

- AI, Programming fundamentals and Problem solving, Probability and statistics

Course Objectives:

- Introduce Human learning aspects and Machine learning.
- Understand primitives and methods in learning process by computer.
- Familiarize nature of problems solved with Machine Learning.

Course Outcomes:

After completion of the course, student will be able to

1. Understand fundamentals of machine learning.
2. Device Supervised Classification strategies.
3. Device Logistic Regression.
4. Demonstrate Distance Based Models and Probability Based Models.
5. Familiarize the concept of clustering techniques for real world applications.
6. Apply Dimensionality Reduction and Association Rules.

Unit I:	Introduction to Machine Learning	6 Hrs

Introduction to Machine learning (ML), Need of Machine learning, Relationship between ML and human learning, Examples of Machine Learning Problems, Learning Process, Learning methods, Forms of learning, Training versus Testing, Characteristics of Machine learning tasks, Descriptive, Predictive and Prescriptive tasks ML Techniques: Supervised, Semi- Supervised, Unsupervised and Reinforcement Learning.

Feature Selection Techniques in Machine Learning, Data Pre-processing operations and their requirements.

Machine Learning Perspective of Data and Feature Engineering, Exploratory Data Analysis (EDA), Performance measures.

Case Studies: EDA to explore types of customers.

Unit II:	Regression	6 Hrs

Regression: Correlation Coefficient, Pearson, Spearman and Kendall Correlation, Linear Regression, Simple Linear Regression, Multiple Linear Regression, Assessing performance of Regression- MSE, MAE, MAPE, R2 Score, Adjusted R2, Overfitting, Underfitting.

Polynomial Regression, Multivariate Regression, Regression Diagnosis, Nonlinear Regression

Regularization Methods: Ridge, LASSO, Elastic Net Regression.

Case Studies: Sales and budget Company

Unit III:	Supervised Learning -I	6 Hrs

Classification: Binary Classification, Multi-Class Classification, Multi-Label Classification, Imbalanced Classification, Confusion Matrix, Classification Assessment- Precision, Recall, F1-Score and Accuracy. Machine Learning Algorithms based on Classification: Logistic Regression- Sigmoid Function, Finding Probalility, Data Model : Receiver Operating Characteristic (ROC),Area Under Curve (AUC), Decision Tree Classification- Entropy, Gini Index, Classification and Regression Trees.
Case Studies: Classification of Movie Category

Unit IV:	**Supervised Learning-II**	**6 Hrs**

Distance Based Models: Neighbors and Examples, Nearest Neighbor Classification, Finding values of K, Distance Measures.
Kernel Based Models: Support Vector Machines, Linear SVM, RBF SVM, Sigmoid SVM, Polynomial SVM.
Probability Based Models: Conditional Probability, Bayes Theorm, Naive Bayes Classification, Bayesian Regression.
Case Studies: classification algorithm for student learning capacity

Unit V:	**Unsupervised Learning-I**	**6 Hrs**

K-means Clustering- Introduction to Clustering, Algorithm, Elbow Method, Sillhoutte Score Hierarchical Clustering- Dendrogram, Distance Measures, Ward method
K-medoids Clustering, K-Propotype Clustering, DBSCAN, Performance Evaluation of Clustering, Real Life Example of Clustering.
Case Studies: Clustering algorithm for student segmentation based on marks.

Unit VI:	**Mining and Dimensionality Reduction**	**6 Hrs**

Association Rules- Rules Mining, Support, Confidence, Lift, Conviction, Leverage, Apriori Algorithm, FP-Growth Algorithm.
Dimensionality Reduction- Curse of Dimensionality, Normalization, Standardization, Eigen Vector and Values, Support Vector Decomposition, Principal Component Analysis, Factor Analysis.
Case Studies: Market basket analysis

Text Books:

1. EthemAlpaydin: Introduction to Machine Learning, PHI 2nd Edition-2013
2. Peter Flach: Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press, Edition 2012

Reference Books:

1. C. M. Bishop: Pattern Recognition and Machine Learning, Springer 1st Edition-2013.
2. Ian H Witten, Eibe Frank, Mark A Hall: Data Mining, Practical Machine Learning Tools and Techniques, Elsevier, 3rd Edition.
3. Tom M. Mitchell, Machine Learning: A multistrategy approach

List of Assignments:

1	Using suitable dataset,Implementation of Linear Regression for predicting weight of a person when his height is known.
2	The dataset is a list of brain weight and body weight measurements from a bunch of animals in the form of tsv file. Create the linear regression model and perform the following: 1. Define dependent and independent variables. 2. Find accuracy score 3. Convert train (80%) and Test (20%) data to test the accuracy. 4. Perform the prediction 5. Plot the linear model

3	Create the multiple regression model for the dataset of house. This will be used the predict the price of the home based on at least five factors. Decide the dependent and independent variables. 1. Find accuracy score 2. Convert train (80%) and Test (20%) data to test the accuracy. 3. Perform the prediction 4. Find mean squared error. 5. Print values of coefficients and intercept 6. Plot the linear model (at least four plots on single plane)
4	Using suitable dataset, predict whether a bank note is authentic or fake depending upon the different attributes of the image(such as Variance of wavelet transformed image, curtosis of the image,entropy, and skewness of the image.) of the note.
5	Using suitable dataset Implementation of K-Means Clustering by Silhouette Method.
6	Using suitable dataset Implementation of K-Means Clustering by Elbow Method.

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ADUA32202: Data Science

Teaching Scheme	**Examination Scheme**
Credits: 4	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: 2 Hrs/week	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks
	OR: 25 Marks

Prerequisites:

- Linear algebra
- Fundamental of Probability and Statistics
- Fundamental of Social Networks

Course Objectives:

- To provide insights about the roles of Data Scientists
- To organize data in proper manner
- To predict future values using time series analysis
- To recognize a community by mapping the relationships that connect then as network
- To understand basics of Big Data
- To identify benefits by processing Big data

Course Outcomes:

After completion of the course, student will be able to

1. Demonstrate skill with statistical analysis of data
2. Improve stability and performance of the algorithm
3. Deal with trend analysis over time
4. Apply Big data fundamentals for real time problems
5. Extract hidden patterns

Unit I:	Data similarity and dissimilarity	6 Hrs

Introduction to Data Science, Role and responsibilities of Data Scientist, Data Science project life cycle with cross-industry standard process for data mining (CRISP-DM), Similarity measures for numeric data, Minkowski distance, Euclidean distance, manhattan distance, supremum distance, Mahalanobis, distance, Bhattacharyya distance. Similarity measures for symmetric and asymmetric, binary data, simple matching coefficient, Jaccard, coefficient, hamming distance. Similarity measures for textual data, edit distance, cosine distance, Jaro distance, n-Gram distance

Case Studies: Similarity and dissimilarity measures used for text document.

Unit II:	Data normalization, discretization and reduction techniques	6 Hrs

Data Normalization, Min-Max normalization, z-score normalization, Decimal scaling
Data discretization, Binning, Histogram, discretization, using data clustering techniques, discretization using classification techniques. Data reduction, filtering techniques, sampling techniques, attribute subset selection techniques, detecting outliers
Parameter Optimization techniques : Linear optimization and nonlinear optimization.

Case Studies: Normalization (Or Min-Max scaling) data in excel

Unit III:	Time Series Analysis	6 Hrs

Time series analysis, One at a time, Bearing with time: Pandas time series in action, time series data manipulation. Modelling time series data: Regression, moving averages and exponential smoothing, stationary and seasonality, determining stationarity, autoregression to the rescue.
Case Studies: Autoregressive models

Unit IV:	**Social Network Analysis**	**6 Hrs**

Introduction, Basic Definitions in graphs, Social network Analysis: Basics in NetworkX, Centrality: Drawing Centrality in graphs, PageRank, Ego-Networks, Community detection
Case Studies: Social network analysis of Marketplaces

Unit V:	**Introduction to Big Data**	**6 Hrs**

Overview of Big data, Big Data examples, 3 V's in Big Data, Big data infrastructure and challenges Challenges in Big Data, Big Data Solutions : Google's Solution ,Hadoop, Advantages of Hadoop.
HDFS Overview, Features and goals of HDFS, HDFS Architecture, Namenode, Datanode, Block .

Unit VI:	**Processing in Big Data**	**6 Hrs**

Big data and Hadoop, Hadoop Tools, Ways to execute MapReduce.
Hive: Introduction to Hive, Features of Hive, Hive Architecture, Working of Hive, Data types in Hive, Literals, Complex Types, Database Operations in Hive, Partitioning in Hive.
HBase: Introduction to HBase, HDFS vs. Hbase, Storage Mechanism in Hbase, Architecture, Hbase Shell, General Commands

Text Books:

1. 'Introduction to Data Science' – Igual, Segui; Springer, 2017
2. 'Advanced Data Science and Analytics with Python', Jesus Rogel-Salazar, CRC Press Taylor and Francis Group.
3. 'Fundamentals of mathematical statistics', S. C Gupta, V.K. Kapoor, Sultan Chand and Sons, 2014

Reference Books:

1. 'Elements of Statistical Learning'- Hastie, Tibshirani, Friedman; Springer;2011
2. 'Data Science from Scratch' – Grus; Google Books;2015

List of Assignments: (R/Python)

1	Implementing similarity measures
2	Implement maximum absolute scaling, Min-Max feature scaling and z-score method for normalization
3	Consider a dataset, take value for a quarter for a particular symbol. Save as CSV file and organize them using pandas library. Show the time series for everyday.
4	Consider the nodes as (A,B,C,D,E,F,G,H). Take one of the nodes as central node (ego), say A. Write a program to create ego network.
5	Hadoop Installation on a)Single Node b)Multiple Node
6	Hadoop with MapReduce Examples. Sample input data which contains students related information like student name, year of admission, mode of admission, city, etc. The goal is to Find out Number of students admitted in from different cities.
7	Perform following using HiveQL for Student information system 1) Creating Database tables 2) insert new values in the table 3) Join tables with Hive 4) Find the average grades of students per year

8	Design a application to find the lowest/highest grades from the sample student data, process it using MapReduce.

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ADUA32203: Natural Language Processing

Teaching Scheme	Examination Scheme
Credits: 4	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: 2 Hrs/week	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks
	TW: 25 Marks

Prerequisites:

- Discrete Mathematics
- Data structure & Algorithms
- Probability Theory and Statistics

Course Objectives:

- To get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics.
- To understand theoretical aspects behind applications based on natural language processing (NLP).
- Understand issues and challenges in NLP and their relevance in the classical and modern context.

Course Outcomes:

After completion of the course, student will be able to

1. Understanding of the fundamental concepts in field of NLP
2. Understand morphological aspect behind NLP
3. Recognise Part of Speech (PoS) Tags and understand classic algorithms for the same
4. Understand semantics of a language and study issues in semantic analysis
5. Apply knowledge in designing Information Extraction, Question Answering and Summarization systems
6. Study traditional and statistical model for Machine Translation and its evaluation perspectives

Unit I:	Introduction	4 Hrs

History of NLP, Generic NLP system, levels of NLP, Knowledge in language processing, Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP, Approaches of NLP: Rule based, Data Based, Knowledge Based approaches

Case Studies: Recent advances in NLP

Unit II:	Morphological Analysis	7 Hrs

Types of Morphology: Survey of English and Indian Languages, Finite-State Morphological Parsing, Building a Finite-State Lexicon, Finite-State Transducers, FSTs for Morphological Parsing, The Porter Stemmer, Word and Sentence Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance, Human Morphological Processing, N –Grams- N-gram language model, N-gram for spelling correction

Case Studies: Morphological Analyzer for Affix Stacking Languages: A Case Study of Marathi

Unit III:	Part of Speech Tagging and Parsing	7 Hrs

Word Classes and Part-of-Speech tagging, survey of POS tag sets for English and Indian Languages, Rule based PoS tagging, Transformation-Based Tagging, Evaluation and Error Analysis, Advanced Issues in Part-of-Speech Tagging,

Introduction to CFG, Parsing with Context-Free Grammars: Parsing as Search, Top-Down Parsing, Bttom-Up Parsing, Dynamic Programming Parsing Methods: CKY Parsing, The Earley Algorithm, Partial Parsing: Finite-State Rule-Based Chunking Machine Learning-Based Approaches to Chunking ,
Case Studies: A Part of Speech Tagger for Indian Languages (POS tagger) developed by IIIT, Hyderabad

Unit IV:	**Semantic Analysis**	**6 Hrs**

Fundamentals of Semantic Analysis, Meaning Representation, Computational Semantics: Syntax driven Semantic Analysis, Semantic Augmentations to Context-Free Grammar Rules, Lexical Semantics: Word senses, Relation between senses, WordNet.
Word Sense Disambiguation (WSD): Introduction, Dictionary and Thesaurus Methods for WSD
Coreferences Resolution: Anaphora, Cataphora, Reference Phenomena, Features for pronominal Anaphora Resolution, Pronominal Anaphora Baseline: The Hobbs Algorithm
Case Studies: Role of Semantic Relations in Hindi Word Sense Disambiguation

Unit V:	**Information Extraction, Question Answering Systems and Summarization**	**6 Hrs**

Information Extraction: Named Entity Recognition, Information Retrieval (IR).
Question Answering Systems: IR based Factoid Question Answering, Entity Linking, Knowledge Based Question Answering, Classic QA Models, Evaluation of Factoid Answers.
Summarization: Summarizing single documents, Multi Document Summarization, Content Selection in Multi-Document Summarization, Summarization Evaluation Techniques
Case Studies: A survey of existing efforts in question-answering and summarization systems for Indian languages

Unit VI:	**Machine Translation**	**6 Hrs**

Introduction to Machine Translation (MT), Classical MT & the Vauquois Triangle, Statistical MT, P(F|E): the Phrase-Based Translation Model, Alignment in MT, Training Alignment Models, Symmetrizing Alignments for Phrase-based MT, Decoding for Phrase-Based Statistical MT, MT Evaluation Techniques
Case Studies: Study of MT systems translating or generating Indian Languages

Text Books:

1. Daniel Jurafsky, James H. Martin, "Speech and Language Processing", Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and Hinrich Schutze,, "Foundations of Statistical Natural Language Processing" , MIT Press, 1999.

Reference Books:

1. Siddiqui and Tiwary U.S., "Natural Language Processing and Information Retrieval", Oxford University Press (2008).
2. Daniel M Bikel and Imed Zitouni, "Multilingual natural language processing applications", Pearson, 2013
3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor), "The Handbook of Computational Linguistics and Natural Language Processing"
4. Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit, Steven Bird, Ewan Klein, and Edward Loper, O'Reilly Publication
5. Natural Language Processing with Python CookBook, Krishna Bhavsar, Naresh Kumar, Pratap Dangeti, Packt Publication

Online resources:

1. Natural Language Processing NPTEL Lecture series
   https://www.youtube.com/watch?v=aeOLjFe256E&list=RDCMUC640y4UvDAlya_WOj5U4pfA&start_radio=1&rv=aeOLjFe256E&t=10

List of Assignments:

Although it is not mandatory, the experiments can be conducted with reference to more than one language.

1	Comparative study of available libraries for Natural Language processing with respect to provided functionalities, platform dependence, supported NLP approaches, supported NLP Tasks, advantages and Disadvantages etc.
2	Perform various pre-processing tasks like tokenization, stemming, lemmatization, stop word removal etc using inbuilt functions and using regular expressions
3	Calculate minimum edit distance between two strings.
4	Perform PoS tagging using regular expressions and inbuilt PoS taggers
5	Perform chunking to detect noun, adjective, adverb and verb phrases from given sentence.
6	Study Recursive Descent and Shift Reduce Parser, and use them for parsing a sentence.
7	Perform single-word, multi-word based and polarity-based sentiment analysis
8	Develop a language model to predict next best word.
9	Recognise Named Entities from a given paragraph.

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ADUA32204(A): Internet of Things

Teaching Scheme	**Examination Scheme**
Credits: 4	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: 2 Hrs/week	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks
	OR: 25 Marks

Prerequisites:

- Fundamental of Computer Networks

Course Objectives:

- To understand fundamentals of IoT
- To understand basics of IoT protocols
- To gain knowledge of security in IoT

Course Outcomes:

After completion of the course, student will be able to

1. Understand the fundamentals and need for IoT applications.
2. Compare the different IoT protocols.
3. Design IoT Systems using building blocks of IoT.
4. Explain the security issues in IoT
5. Summarize the concepts of Cloud & Fog Computing.
6. Develop a small IoT system with advancements

Unit I:	Introduction to IoT	6 Hrs

IoT : Definition, Internet of Things: Vision, Emerging Trends,
Economic Significance, Technical Building Blocks, Physical design of IoT, Things of IoT,
Logical design of IoT, IoT functional blocks, IoT communication models, IoT
Communication APIs, IoT enabling technologies, IoT levels and deployment templates, IoT, Issues and Challenges, IOT applications.

Case Studies: Indoor/ Outdoor use cases smart home, smart city

Unit II:	Protocols for IoT	6 Hrs

IoT Protocols: MQTT, CoAP, XMPP and AMQT, IoT communication models
IoT Communication technologies: Bluetooth, BLE, Zigbee, Zwave, NFC, RFID, LiFi, Wi-Fi, Interfacing of wifi, RFID, Zigbee, NFC with development board.

Case Studies: RPL, 6 LoWPAN

Unit III:	IoT and M2M	6 Hrs

Internet of Everything and it's connections, Machine to Machine, Difference between IoT and M2M, Software define Network, Software define Network for IoT, IoT Physical Devices and Endpoints: Basic building blocks of and IoT device, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino Introduction to Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python.

Case Studies: Smart meter, wearable technologies

Unit IV:	Security In IoT	6 Hrs

IoT Security: Vulnerabilities of IoT, Security Requirements, Challenges for Secure IoT, Threat Modelling, Key elements of IoT Security: Identity establishment, Access control, Data and message security, non-repudiation and availability, Security model for IoT.
Case Studies: Avispa

Unit V:	**Cloud Computing and Fog Computing**	**6 Hrs**

Introduction to Cloud Computing, Cloud of Things: Grid/SOA and Cloud Computing, Cloud Middleware, Cloud Standards – Cloud Providers and Systems, Mobile Cloud Computing, The Cloud of Things Architecture. Challenges and issues in cloud Computing. Fog Computing, Need of Fog computing, Fog Computing Architecture
Case Studies: IP Protection and Platform Integrity

Unit VI:	**Industrial IOT**	**6 Hrs**

What is IIoT and connected world? Industry 4.0, Cyber Physical System Architecture, Difference between IoT and IIoT, Architecture of IIoT, Working Principles, IOT Infrastructure, Benefits, Potential, Factory of future, Wearable Technologies, Worker of future, Challenges and Drawbacks of IIOT, Future IIOT.
Case Studies: Industry 4.0 Technologies, Supply Chain Management, Cellular IoT

Text Books:

1. Tomonobu Senju,Parikshit Mahalle,Thinagaran Perumal "IOT with Smart Systems",Springer
2. ArshdeepBahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515
3. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012. ISBN : 9781439892992

Reference Books:

1. Olivier Hersent, Omar Elloumi and David Boswarthick, "The Internet of Things: Applications to the Smart Grid and Building Automation", Wiley, 2012, 9781119958345
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012, ISBN:978-1-119-99435-0

List of Assignments:

1	Study of Raspberry Pi board, GPIO, Modes of operations, operating system installation and interfaces.
2	Write a program to take user input for controlling LED blinking. When user inputs 1, make the LED on else off.
3	Write a program to send analog output to the LED. The program will fade the LED in different brightness.
4	Write a program to read the state of IR sensor to check whether obstacle is present in front of it or not.
5	Write a program to read the environmental temperature and humidity using DHT11 or DHT22 sensor. Trigger the buzzer when temperature crosses the threshold value.
6	Write a program to read the temperature using sensor and communicate it to another computer using TCP socket programming.
7	Write a program control the on/off state of LED using Telegram application. The LED should get controlled using any mobile phone.
8	Write an application to read the temperature using sensor, display it on ThingSpeak graphically. Trigger any action if the temperature crosses the threshold.
9	Create a web application using HTML and PHP to control the on/off state of the buzzer on localhost.

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ADUA32204(B): Augmented Reality Virtual Reality

Teaching Scheme	**Examination Scheme**
Credits: 4	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: 2 Hrs/week	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks
	OR: 25 Marks

Prerequisites:

- Fundamentals of Image processing and computer graphics

Course Objectives:

- Understand the basics concepts of Augmented Reality and Virtual Reality
- Understand the different headsets of virtual reality
- Explore the concepts of Virtual reality and augmented reality to develop 3D virtual environment

Course Outcomes:

After completion of the course, student will be able to

1. Understand basics concepts related to Virtual Reality & Augmented Reality.
2. Identify the importance and application of VR techniques
3. Demonstrate use of VR for app development
4. Identify the importance and application of AR techniques
5. Demonstrate use of AR for app development
6. Demonstrate use of mixed reality

Unit I:	Introduction	6 Hrs

Immersive technologies, methods and techniques, tools, introduction to Virtual Reality, augmented and mixed reality, spectrum, difference between AR/VR/MR, Applications of AR/VR/MR

Case Studies: Tools and techniques in AR /VR

Unit II:	Virtual Reality	6 Hrs

Types of VR, non-immersive and immersive, full immersive, HMD for immersive, HMD types – standalone, PC based or mobile based, working principles of HMD, Working of VR, role of sense organs in VR app, VR app development cycle - Web VR/ mobile VR/ headset VR, tools and technologies for VR app development

Unit III:	Virtual Reality app using Game platform	6 Hrs

Introduction to game platforms – Unity, Unreal; Basics of Unity and C# Programming, introduction to game development using unity, UI development in unity, assets introduction, VR app -end-to-end demo using unity, challenges of VR app development

Case Studies: VR application in real life scenario.

Unit IV:	Augmented Reality	6 Hrs

Introduction to Augmented Reality, types , mobile AR/ Web AR/ headset AR, working principle, image processing principles in AR app, tools and technologies for AR app development

Unit V:	Augmented Reality Applications	6 Hrs

Introduction to AR app development platforms – Vuforia, Wikitude, Vuforia engine, functions, Vuforia and Unity, challenges of AR app development **Case Studies:** AR application in real life scenario.		
Unit VI:	**Mixed Reality and advancements**	**6 Hrs**
Introduction, applications, technology requirements for MR, computer vision with open cv, Challenges and security issues in AR/VR and MR Case Studies: End to end application development with AR/VR/MR.		
Text Books:		
1. Tony Parisi , Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, Wiley, 2015. 2. Murray Ramirez , Virtual Reality for Beginners!: How to Understand, Use & Create with VR, by, 2016. 3. Roger Froze, Augmented Reality For Beginners!: Principles & Practices for Augmented Reality & Virtual Computers, 2016		
Reference Books:		
1. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, 3D User Interfaces, Theory and Practice, Addison Wesley, USA, 2005. 2. Oliver Bimber and Ramesh Raskar, Spatial Augmented Reality: Meging Real and Virtual Worlds, 2005.		
Online resources:		
1. https://arvr.google.com/ 2. http://vr.cs.uiuc.edu/vrbook.pdf		

List of Assignments based on:

1.	Use of VR head sets – Google cardboard, Samsung Gear, HTC, Oculus, Hololens, google glass, non-immersive – mobile/tablet/desktops
2.	Unity installation
3.	Unity game development
4.	Unity VR app development
5.	Use of AR apps using different hardware - Hololens, google glass, mobile/tablets/desktops
6.	Install Vuforia sdk & other plugins, Adding Vuforia license key Add Image Target, Place 3D objects
7.	AR App development using Vruforia
8.	Vruforia/unity integration

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ADUA32204(C): Fundamentals of Blockchain Technology

Teaching Scheme	**Examination Scheme**
Credits: 4	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: 2 Hrs/week	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks
	OR: 25 Marks

Prerequisites:

- Data Structure and Algorithm
- Database management system
- Fundamental of Computer Network

Course Objectives:

- Explain what blockchain is and how it works
- Describe how bitcoin operates and how it relates to blockchain
- Explore Consensus algorithms
- Learn about Hyperledger and Ethereum
- Evaluate and describe other applications of blockchain
- Articulate and describe the limitations of blockchain

Course Outcomes:

After completion of the course, student will be able to

1. Explore the major components of Blockchain
2. Describe Cryptocurrency, Bitcoin, its operations and consensus.
3. Study approach to design blockchain applications
4. Demonstrate smart contract development in solidity using Ethereum Platform
5. Introduce Hyperledger Frameworks and Fabric Concepts
6. Evaluate potential Blockchain uses cases from a business, legal, and engineering perspective.

Unit I:	Introduction to Block Chain	6 Hrs

Introduction to Blockchain, Its characteristics, Opportunities using blockchain, Brief history of Blockchain, Evolution of computer applications, Centralized applications, Decentralized applications, Stages in blockchain evolution, Blockchain 1.0, Blockchain 2.0 Blockchain 3.0,Consortium-Business focused, Technology focused, Hybrid, ledgers, distributed ledgers, Restrictions on sharing ledgers-Types based on Authority to participate, Types based on Access to network, Forks, Public blockchain environment, Types of players in blockchain ecosystem, Players in market- Bitcoin, Multichain, Ethereum, Hyperledger, R3 Corda etc.

Unit II:	Blockchain Concepts	6 Hrs

Chaining of blocks, Hasing, Markle tree, Consensus-Proof-of-Work, Proof-of-Stake, Byzantine general problem, Byzantine fault tolerant system, Directed Acyclic graph, Proof of capacity, Mining and finalizing blocks, Currency (Tokens),Security on blockchain, Data storage on blockchain, UTXO Models, Global State Models, Wallets, Coding on blockchain smart contracts, Peer-to-peer network, Types of blockchain nodes-Miner, Full, Administrative, Light-weight, Risk assessment, Life cycle of blockchain transaction

Unit III:	Architectring Blockchain Solutions	6 Hrs

Obstacles in blockchain usage, Blockchain relevance evaluation framework, Blockchain solution reference architecture-Core, platform, service, applications, Types of blockchain applications-Fully decentralized, simple solutions, enterprise solutions, Cryptographic tokens-Utility, Security, ERC, Typical solution architecture for Enterprise use case, Types of blockchain solution-Value transfer, Provenance, Identity management, Data sharing, Architecture Considerations, Architecture with blockchain platform, Approach for designing blockchain applications

Unit IV:	**Ethereum Blockchain**	**6 Hrs**

Tuna Fish tracking use case, Ethereum ecosystem and development, Tool stack, Ethereum virtual machine, Smart contract programming, IDE-Remix, Visual studio code, Truffle framework, Ganache, Unit testing, Ethereum accounts, MyEther wallet, Ethereum network, Infura, Etherscan, Ethereum clients, Decentralized applications, Metamask, Tuna Fish use case implementation,Open Zepplin contracts, Best practices for Ethereum smart contract development

Unit V:	**Hyperledger Blockchain**	**6 Hrs**

Car ownership tracking use case, Architecture of Hyperledger fabric, Transaction flow, Fabcar use case implementation-Fabric installation and application development, Golang, FabCar chaincode,Fabric network setup,invoking chaincode using CLI,Invoking chaincode functions using client applications,Best practices for chaincode development

Unit VI:	**Block Chain Use Cases**	**6 Hrs**

When to Use a Blockchain (Limitations and Misconceptions), Challenges for Blockchain, Internet of Things-Medical Record Management System-Blockchain in Government and Blockchain Security-Blockchain Use Cases –Finance, Blockchain in Supply chain traceability

Text Books:

1. Ambadas Tulajadas Choudhari, Arshad Sarfarz Ariff, Sham M R, "Blockchain for Enterprise Application Developers" Willey publications, ISBN: 9788126599967,2020
2. Josh Thompson, 'Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming', Create Space Independent Publishing Platform, 2017.
3. Kevin Werbach, The Blockchain and the New Architecture of Trust
4. Mastering Ethereum Building Smart Contracts and DApps, Andreas M. Antonopoulos, Gavin Wood, O'Reilly

Reference Books:

1. Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks by Bashir, Imran,2017.
2. Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits
3. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder.
4. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.
5. Joseph Bonneau et al, SoK: Research perspectives and challenges for Bitcoin.

Online resources:

1. Hyperledger Fabric - https://www.hyperledger.org/projects/fabric

List of Assignments:

1	Study of various websites related Blockchain like a. http://emn178.github.io/online-tools/sha256.html

	b. https://timestampgenerator.com/generate-hash/sha256 c. www.blockchain.com d. www.passwordsgenerator.net/sha256-hash-generator/ e. https://etherscan.io/ f. https://ethereum.org
2	Case Study on various use cases of Blockchain. a. Identify minimum FIVE use cases b. Identify various processes involved in each use case c. Identify drawbacks of existing system/process d. Provide solutions with Blockchain Technology e. Identify minimum TWO processes from each use case for writing smart contracts
3	Comparative study of various Blockchain Platforms (Bitcoin, Ethereum, Hyperledger, Ripple, Corda, R3…).
4	Studying basics of Bitcoin and Cryptocurrency a. Create a Wallet and Account b. Send and receive bitcoin
5	Study of SOLIDITY programming and REMIX Web based IDE.
6	Write Smart Contract in SOLIDITY a. To display "Hello World" b. To study Basic Data Types & Statements,enum,struct,string c. To study State Variables, Functions. b. To demonstrate passing values among two functions c. To use constructor
7	Write Smart Contract in SOLIDITY to demonstrate a. Working of arrays b. Working of address data type c. Working of Mapping d. Working of Events e. Working of inheritance
8	Create a simple block in Python

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IOEUA32205F: Explainable Artificial Intelligence (XAI) for Engineering Applications

Teaching Scheme	**Examination Scheme**
Credits: 3	Continuous Internal Evaluation (CIE): 20 Marks
Lectures: 3 Hrs/week	In-Semester Examination (ISE): 30 Marks
Practical: -	Skills & Competency Exam (SCE): 20 Marks
	End Semester Examination (ESE): 30 Marks

Prerequisites:

- Fundamentals of Probability & statistics
- Machine Learning and Deep Learning basics
- Python for Data Science

Course Objectives:

- Making students familiarize with the need of XAI for engineering applications and its central concepts
- Making students understand with the mathematical concepts like ensemble models and non-linear models to analyse the problems
- Providing tools and techniques of XAI for design and building solutions

Course Outcomes:

After completion of the course, student will be able to

1. Learn the fundamental concepts of XAI and its use to build various use cases in engineering domain
2. Compare merits and demerits of linear and non-linear model in problem analysis
3. Provide knowledge about using ensemble learning and contrastive explanations and LRP for machine learning
4. Performs parametric evaluation of AI-based and XAI-based solutions
5. Apply the knowledge for drafting clear requirements to build end-to-end XAI solution
6. Learn and apply knowledge of XAI and tools for application and protocol development in engineering applications

Unit I:	Introduction to Explainable Artificial Intelligence	6 Hrs

Artificial Intelligence, Need for XAI, Explainability vs. Interpretability.

Explainability Types: Intrinsic explanation, Post-hoc explanation, Model specific, Model agnostic, Local interpretation, Global interpretation, Sublocal interpretation, Textual explanations, Visual explanations.

Tools for Model Explainability: SHAP, LIME, ELI5, Skater, Skope_rules.

Evolution of XAI, Biasness, and Reliability, Challenges to achieve explainable AI and design issues

Case Studies: Fraud Detection, Online Recommendations, Credit and Loan Decision Making.

Unit II:	Explainability for Linear Models	6 Hrs

Linear Models, Linear Regression

VIF and the Problems It Can Generate : Final Model, Model Explainability

Trust in ML Model: SHAP - Local Explanation and Individual Predictions in a ML Model, Global Explanation and Overall Predictions in ML Model, LIME Explanation and ML Model, Skater

Explanation and ML Model, ELI5 Explanation and ML Model, Logistic Regression: Interpretation, LIME Inference.
Case Studies: **Linear Regression**

Unit III:	**Explainability for Non Linear Models**	**6 Hrs**

Non-Linear Models , Decision Tree Explanation, **Data Preparation for the Decision Tree Model** : Creating the Model , Decision Tree – SHAP, Partial Dependency Plot, PDP Using Scikit-Learn, Non-Linear Model Explanation – LIME, Non-Linear Explanation – Skope-Rules
Case Studies: Comparison of Husky Dog and Wolf

Unit IV:	**Explainability for Ensemble Models**	**6 Hrs**

Ensemble Models: Types of Ensemble Models
Why Ensemble Models?, Using SHAP for Ensemble Models, Using the Interpret Explaining, Boosting Model**, Ensemble Classification Model:** SHAP, Using SHAP to Explain Categorical Boosting Models, Using SHAP Multiclass Categorical Boosting Model, Using SHAP for Light GBM Model Explanation
Case Studies: Model Interpretability

Unit V:	**Counterfactual Explanations for XAI Models**	**6 Hrs**

AI Model Fairness Using a What-If Scenario: What Is the WIT (Google Tool)?, Evaluation Metric. Counterfactual Explanations for XAI Models: What Are CFEs?, Implementation of CFEs, CFEs Using Alibi, Counterfactual for Regression Tasks.
Case Studies: Causability Algorithms and Applications

Unit VI:	**Contrastive Explanations and LRP for Machine Learning**	**6 Hrs**

What Is CE for ML?, CEM Using Alibi, Comparison of an Original Image vs. an Autoencoder Generated Image, CEM for Tabular Data Explanations.
Layer wise relevance propagation (LRP): Introduction, Working Principle, Mathematical Modeling.
Case Studies: Pertinent Negatives, Explanation based on missing

Text Books:

1. Practical Explainable AI Using Python: Artificial Intelligence Model Explanations Using Python-based Libraries, Extensions, and Frameworks Pradeepta Mishra

Reference Books:

1. Hands-On Explainable AI (XAI) with Python: Interpret, visualize, explain, and integrate reliable AI for fair, secure, and trustworthy AI apps by Denis Rothman

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ADUA32206: Design Project II

Teaching Scheme	**Examination Scheme**
Credits: 2	TW: 25 Marks
Lectures: 1 Hrs/week	
Practical: 2 Hrs/week	

Prerequisites:

- Design Project I

Course Objectives:

- To make students the understand the need of project design
- To make students familiar with tools and process in the product development cycle

Course Outcomes:

After completion of the course, student will be able to

1. Demonstrate a working model with design principles
2. Work with team and showcase skills desired for product development
3. Think and act rationally and logically in product development process

Unit I:	Concept Generation, design, Prototyping	3 Hrs

Creative techniques and tools for concept generation, concept evaluation matrix, concept selection matrix, context, ethics in design
Product prototyping, types, other parameters - security and safety issues

Unit II:	Design & implementation	3 Hrs

Challenges in design, Integrating components, tools usage, UI/UX aspects, tools, configuration management

Unit III:	Evaluation tools and Testing	3 Hrs

Tools for evaluation, testing approaches to build the product, verification

Unit IV:	Deployment & Maintenance	3 Hrs

Final product deployment tasks, delivery tasks, maintenance, User Retrospection and Review meetings

Text Books:

1. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011
2. John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design",Cengage learning (International edition) Second Edition, 2013.
3. Roger Pressman, "Software Engineering a Practitioner`s Approach", Published by McGraw-Hill.

Reference Books:

1. A.K. Chitale and R.C. Gupta, "Product Design and Manufacturing", Prentice Hall
2. William lidwell, kritina holden, Jill butter, "Universal principles of design" Rockport, 2015.

List of Assignments:

Assignments to be based on continuation with Problems statements from Design Project I.
Can be on: IOT application development
Image processing & NLP & analytics
IOT and cloud convergence for smart computing
End to end web development (full stack development)
Agile/Kanban or Lean Startup approach towards the entire product development desired along with use of tools like Jira or any other is recommended