Dwaraka Doss Goverdhan Doss Vaishnav College [Autonomous]

Shift – II

MASTER OF SCIENCE IN DATA SCIENCE

CHOICE BASED CREDIT SYSTEM (CBCS)

WITH

GRADING SEMESTER SYSTEM WITH CREDITS

M.Sc.(DataScience)

Scheme of Examination

(For the students admitted during the academic year 2025-2026 and onwards)

Dwaraka Doss Goverdhan Doss Vaishnav College[Autonomous]

Shift – II

FACULTY OF SCIENCE
MASTER OF SCIENCE DEGREE COURSE IN
DATA SCIENCE

CHOICE BASED CREDIT SYSTEM (CBCS)WITH GRADING
SEMESTER SYSTEM WITH CREDITS

M.Sc.(Data Science)
Scheme of Examination

(For the students admitted during the academic year 2025-2026 and onwards)

POSTGRADUATE PROGRAMME

REGULATIONS

1. ELIGIBILITY FOR ADMISSION

Candidates for admission to the first-year program leading to the Degree of Master of Science in Data Science (M.Sc. – DS) will be required to possess: A pass in B.Sc. Computer Science or its equivalents / B.Sc. Data Science / B.Sc. Data Analytics or its equivalents / B.Sc. Statistics or its equivalents/BCA/B.Sc. Electronics or its equivalents/B.E.CSE/IT/ECE/EEE and E&I or its equivalents.

COURSE OF STUDY

First Year –Semester 1						
Course	**Course Title**	**No. of Hours**	**Credits**	**End-Semester Examination (ESE)**	**Continuous Internal Assessment (CIA)**	**Total Marks**
Core I	Data Visualization for Analytics using R and Python	7	5	75	25	100
Core II	An Introduction to Data Analytics	7	5	75	25	100
Core III	**Practical I** : Data Visualization ..for Analytics Laboratory Using R and Python Lab	6	4	60	40	100
Elective I	I. Discrete Mathematics II. Linear Algebra III. Statistics for Data Science (Among three anyone can be	5	3	75	25	100

	chosen)					
Elective II	I. Digital Image Processing II. Web Database and Information System III. Data Science Ethics (Among three anyone can be chosen)	5	3	75	25	100
	Total	**30**	**20**			

First Year –Semester II						
Course	**Course Title**	**No. of Hours**	**Credits**	**End-Semester Examination (ESE)**	**Continuous Internal Assessment (CIA)**	**Total Marks**
Core IV	NoSQL Database Management	6	5	75	25	100
Core V	Descriptive and Discovery Analytics	6	5	75	25	100
Core VI	**Practical II** No SQL Database Management Laboratory	6	4	60	40	100
Elective III	I. Regression Analysis II. Probability And Distribution Models III. Design And Analysis Of Experiments (Among three anyone can be chosen)	4	3	75	25	100
Elective IV	I. Cyber Security II. Digital Forensics III. Big Data Security (Among three anyone can be chosen)	4	3	75	25	100
SEC -I	Descriptive and Discovery Analytics Lab	4	2	75	25	100
Internship*/Industrial Activity		-	-			
	Total	**30**	**22**			

*Internship during summer vacation. The Credits shall be awarded in Semester III Statement of Marks

Second Year –Semester III						
Course	**Course Title**	**No. of Hours**	**Credits**	**End-Semester Examination (ESE)**	**Continuous Internal Assessment (CIA)**	**Total Marks**
Core VII	Cryptography and Network Security	6	5	75	25	100
Core VIII	Block Chain & Crypto currency Fundamentals	6	5	75	25	100
Core IX	Predictive Analytics	6	5	75	25	100
Core X	**Practical III** Predictive Analytics Lab	6	4	60	40	100
Elective–V Industry Module	Cloud Analytics	3	3	75	25	100
SEC-II	Data Mining and Knowledge Discovery	3	2	75	25	100
	Internship/Industrial Activity	-	2	-	-	-
	Total	**30**	**26**			

Second Year –Semester IV						
Course	**Course Title**	**No. of Hours**	**Credits**	**End-Semester Examination (ESE)**	**Continuous Internal Assessment (CIA)**	**Total Marks**
Core XI	Exploratory Data Analysis	6	5	75	25	100
Core XII	**Practical IV** Exploratory Data Analysis Lab	6	5	60	40	100
Core XIII	Project with Viva Voce	8	4	60	40	100
Elective VI	I. Green Computing II. Nature Inspired Computing III. Sentiment Analysis	4	3	75	25	100

	(Among three anyone can be chosen)					
Elective VII	I. Graph Theory & Network Analysis II. Reinforcement Learning **III.** High Performance Computing for Data Science	4	3	75	25	100
SEC-III Professional Competency Skill	Advanced Computer Vision	2	2	75	25	100
Extension Activity	Field Trip	-	1			
	Total	**30**	**23**			

Overall Credit Distribution for PG Course

S.No	Course Details	Credits
1	Core Course [13 Courses x 4/5Credits]	61
2	Elective Course [7 Courses x 3 Credits]	21
3	Skill Enhancement Courses [3 Courses x 2 Credits]	6
4	Internship	2
5	Extension Activity	1
		91

PROGRAMME EDUCATION OBJECTIVES [PEO'S]:

The Programme Education Outcomes of M.Sc. [Data Science] are to

PEO1	Apply terminologies and principles in problem solving adapting to applications of Mathematics, Statistics, Business and emerging computing technologies in the field of Data science to conceptualize real world problems.
PEO2	Exhibit proficiency as data analytics professionals through latest technologies to business and organizations in demonstrating the ability for work efficacy
PEO3	Work and collaborate with interdisciplinary backgrounds as a part of team to address the contemporary issues with innovation
PEO4	Pursue entrepreneurship, research and higher studies associated with the program to function efficiently and effectively addressing challenging problems innovatively in the society
PEO5	Communicate effectively, recognize and incorporate societal needs and constraints in their professional endeavour
PEO6	Practice their profession as Data Analyst with high regard to ethical responsibilities

PROGRAM OUTCOMES (PO)

At the end of the programme the student will be able:

PO1	Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline
PO2	Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resource, ICT tools to enhance knowledge base and stay abreast of recent developments
PO3	Ability to handle/use appropriate tools/ techniques/ equipment with an understanding of the standards operation procedures safety aspects/ limitations.
PO4	Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions / solutions
PO5	Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solution. Exhibit organisational skills and the ability to manage time and resources

Mapping of POs TO PEOs

PEO/PO	PO 1	PO 2	PO 3	PO 4	PO 5
PEO 1	3	3	3	3	3
PEO 2	3	3	2	3	3
PEO 3	3	3	2	3	3
PEO 4	3	3	3	3	2
PEO 5	3	3	3	3	3
PEO 6	3	3	2	3	3

CRITERIA FOR MAPPING
3- STRONG 2- MEDIUM 1- LOW

PROGRAMME SPECIFIC OUTCOMES [PSO's]

PSO1	Take leading roles in industry, academia, entrepreneurship and applications.
PSO2	Analyze the data and apply statistical with machine learning concepts, and interpret the results obtained in their operational context. .
PSO3	Scientific, ethical and socially responsible approach for conducting and contributing to research in their specific area of study and to international trends in and related to their field of study
PSO4	Implement the concepts of Statistics, optimization techniques, Data Repository, Data Analytics on real-world problems, and take a decision on the problem.
PSO5	Identify the appropriate mathematical and statistical techniques to solve the problems and give right solution to the industry and scientific communities, and the society..

Semester	I
Subject	CORE I – DATA VISUALIZATION FOR ANALYTICS USING R AND PYTHON
Maximum Marks	CIA- 25 Marks ESE-75 Marks
Credits/ Instruction Hours	5 Credits / 7 Hours
Exam Duration	3 Hours

Objectives

- Understand the principles of data visualization, including the importance of visual representation in data analysis and storytelling.
- Gain proficiency in using key libraries for data visualization in R (e.g., ggplot2, plotly) and Python (e.g., Matplotlib, Seaborn, Plotly).
- Learn techniques for cleaning and transforming data to make it suitable for visualization.
- Develop skills to create a variety of visualizations (e.g., bar charts, line graphs, scatter plots, heatmaps) to effectively communicate data insights.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Gain expertise in data visualization principles to transform data into actionable insights	K1, K2, K3, K4, K5
CO2	Develop skills in manipulating and visualizing data using both R and Python for versatile programming applications.	K1, K2, K3, K4, K5
CO3	Create various plots and graphics through hands-on exercises to effectively communicate data.	K1, K2, K3 & K4
CO4	Emphasize the application of visualization techniques in real-world scenarios to inform data-driven decisions	K1, K2, K3, K4, K5
CO5	Establish a strong foundation for further studies in data analytics, statistics, and machine learning/	K1, K2, K3, K4, K5

Mapping of Course Outcomes to Program Outcome:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong 2-Medium 1-Low

UNIT I

Introduction to Data Visualization: Data, Information, Knowledge, Data Analysis and Insights, Transforming Data into Information, Transforming Information into Knowledge, Transforming Data into Insight, Data Visualization History, Where does Data Visualization fit indecision making, Kind of Visualization needed for a particular domain, Data Visualization Tools for Analytics.

UNIT II

Basic Data Manipulation in R: Installing and getting help in R, Data types in R, Data Import and Export, Basic Data Manipulation, Summary Statistics, Vectors-Generating Vectors, Vector Indexing, Vectorized Functions, Filtering Vectors, Matrices-General Operations, Indexing, Preliminary Analysis, Adding, Deleting Elements Matrices. Filtering Matrices, Apply function, Data Frames-Matrix operations on Data Frames, Factors and Tables.

UNIT III

BasicGraphicsandSampleAnalysis:Histogram,AsimpleBarPlot,AnInteractiveBarPlot,Scatter Plot-Scatter Plot with texts, labels and lines, An interactive Scatter Plot, Box Plot, Plotting Multiple Curves, Lines function, Adding Legend, Text in a graph, Pin pointing a Location, Replaying a Plot, the Polygon function, lowness function, Graphing an explicit function, Organizing anAnalysis.3 D Plots, Saving Plots, Gnattor Timeline Chart, Interactive Bubble Chart, Waterfall Chart, Dendograms with colours and labels.

UNIT IV

Basic Concepts in Python for Visualization: Installing and getting help in Python, Data types in Python, Data Import and Export, Basic Data Manipulation, Summary Statistics Bar graphs, Pie charts, Box Plots, Scatter Plots, Bubble Charts, KDE Plots.

UNIT V

Interactive Plotting and IDE in Python: Types of Interactive tools-I Python, Plotly, Interative Plotting-NumPly, SciPly and MKL functions, Types of Python IDE-PyCharm, PyDev, Visualization Plots using Anaconda, , Visualization using matplotlib

TEXT BOOKS

1. KirthiRaman,"MasteringPythonDataVisualization",PacktPublishingLtd.,UK.
2. AtmajithsinghGohil,"RDataVisualizingCodebook",PacktPublishingLtd.,UK.
3. BrianS. Everitt and Torsten Hothorn, "A Handbook of Statistical AnalysesUsingR",2nd Edition, Tayor and Francis Group.
4. Normann Mattloff, "The Art of R Programming", No Starch Press, SanFransisco.

REFERENCES

1. Chambers,J.M.(1998),"Programming with Data",NewYork, USA:Springer.
2. Meyer,D.,Zeileis,A.,Karatzoglou,A.,andHornik,K.(2006),"Visualizing Categorical Data", URL http://CRAN.R-project.org, R package version 0.9-91.

Semester	I
Subject	CORE II –AN INTRODUCTION TO DATA ANALYTICS
Maximum Marks	CIA- 25 Marks ESE-75 Marks
Credits/ Instruction Hours	5 Credits / 7 Hours
Exam Duration	3 Hours

Objectives

- Understand what data analytics is and its role in modern decision-making across various industries.
- Learn about the four main types of analytics: descriptive, diagnostic, predictive, and prescriptive.
- Gain insight into various data collection methods, including surveys, experiments, and existing data sources.
- Develop skills in data cleaning, preprocessing, and transformation to ensure data quality for analysis.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Explore the definition, significance, and applications of data analytics and big data across various sectors, including healthcare, advertising, and smart cities.	K1, K2, K3, K4, K5
CO2	Gain insights into the hardware architecture required for data analytics, distributed file systems like Hadoop, and comparisons between traditional data warehousing and big data solutions.	K1, K2, K3, K4, K5
CO3	Learn the stages of data analytics, including descriptive, predictive, prescriptive, and discovery analytics, as well as the complete project life cycle from discovery to operationalization.	K1, K2, K3 & K4
CO4	Analyze how data analytics is utilized in diverse fields such as healthcare, business, sports, and disaster management, focusing on personalized treatments, targeted advertising, and more.	K1, K2, K3 & K4
CO5	Examine practical case studies from organizations like commonwealth Bank, Aetna Innovation Labs, and Walmart to understand successful big data analytics implementations and their impacts.	K1, K2, K3, K4, K5

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong 2-Medium 1-Low

UNIT I

Data Analytics and Big Data: Data Analytics- Definition, Launch, Importance of Data Analytics, Big Data-, Definition, Sources, Characteristics, Data Analytics Applications-Biomedical, Mobile Advertising, Sentimental Analysis, Disaster Management, Recommendation Engines, Smart Cities.

UNIT II

Architectural Elements for Data Analytics: Hardware Architecture for Data Analytics, Characteristics, Requirements, Distributed File System for Big Data- Commodity Cluster for Big Data, Storage and Programming Model of Hadoop for Big Data, Data in Warehouse and Data in Hadoop- a comparison, Data Analytics on Cloud.

UNIT III

Stages of Data Analytics and Data Analytics Project Life Cycle: Stages of Data Analytics- Descriptive Analytics, Discovery Analytics, Prescriptive Analytics, Predictive Analytics. Data AnalyticsProjectLifeCycle-Background,Phase1:Discovery, Phase2-DataPreparation,Phase3: Model Planning, Phase 4: Model Building, Phase 5: Communicating Results, Phase 6: Operationalize, Roles of Data Scientist.

UNIT IV

Analytics Applications: Data Analytics in Health Care-Personalized Treatment, Business-Targeted advertising, introducing a new Product, Fraud Prediction, Data Analytics in Sports, Disaster Management, Data Analytics for Smart Cities, Requirements for being successful with Big Data Analytics.

UNIT V

Data Analytics Projects-Case Studies: Big Data Analytics in: Common wealth Bank of Australia for Risk Analysis, Aetna Innovation Labs Analytics for Improving Health, Walmart's analytics to improve online shopping, Jio and Data Analytics.

TEXT BOOKS

1. "A Guide to Big Data Analytics",Datameer.com.
2. Vignesh Prajapati,"Big Data Analytics with R and Hadoop", Pack Publications.
3. D.Dietrich,B.Heller,B.Yang,"Data Science and Big Data Analytics",EMC Education Services.
4. DeWitt, S.Madden, and M.Stonebraker,"A Comparison of Approaches to Large-Scale Data Analysis", SIGMOD Conference 2009.
5. Steven Cooper," Data Science from Scratch", Data Science.

REFERENCES

1. "Data Analytics Made Accessible" by Anil Maheshwari
2. Data Science for Business "by Foster Provost and Tom Fawcett
3. "Naked Statistics: Stripping the Dread from the Data "by Charles Wheelan
4. "Practical Statistics for Data Scientists" by Peter Bruce and Andrew Bruce

Semester	I
Subject	CORE III PRACTICAL I – DATA VISUALIZATION FOR ANALYTICS USING R AND PYTHON LAB
Maximum Marks	CIA- 40 Marks ESE-60 Marks
Credits/ Instruction Hours	4 Credits / 6 Hours
Exam Duration	3 Hours

Objectives

- Learn the stages of data analytics, including descriptive, predictive, prescriptive, and discovery analytics, as well as the complete project life cycle from discovery to operationalization.

LIST OF PROGRAMS

1. Software and Package Installation Steps.
2. Loading different kinds of data formats.
3. Using functions to find statistics of Data.
4. Exercises to work with Vectors and Matrices.
5. Selecting the right plot for a particular Data Set.
6. Scatter plot exercises with Text, Labels, Lines and Connecting Points.
7. Interactive Scatter Plots.
8. Relationship between two Continuous variables of a Dataset using Scatter Plot
9. Plotting categorical variables using different Bar Plots.
10. Interactive Bar Plots.
11. Histograms, merging Histograms.
12. Inferring from different Visualizations for possible prediction.
13. Comparing different datasets using suitable visualization technique

Semester	I
Subject	ELECTIVE I: DISCRETE MATHEMATICS
Maximum Marks	CIA-25Marks ESE-75 Marks
Credits/Instruction Hours	3 Credits / 5 Hours
Exam Duration	3 Hours

Objectives

- To develop knowledge and understand concepts of mathematical induction, logic, functions and relations.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	To introduce Mathematical Logic to understand the equivalence of statements.	K1, K2, K3, K4, K5
CO2	To acquaint the students with Inference Theory and predicate calculus to understand partial order and partition.	K1, K2, K3, K4, K5
CO3	To introduce fundamental principles of Combinatorial Counting techniques	K1, K2, K3 & K4
CO4	To explain generating functions and their utility in solving recurrence relations	K1, K2, K3 & K4
CO5	To introduce graph models and tree structures with basics and significance of reversibility.	K1, K2, K3, K4, K5

Mapping of CO with PO &PSO:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong 2-Medium 1-Low

UNIT I

Sets, Sequences and Functions: Sets-Some Special Sets-Set Operations-Functions-Sequences-Properties of Functions-Propositions-Conditional Propositions and Logical Equivalence-Arguments and Rules of Inference-Quantifiers-Nested Quantifiers. Elementary Logic: Informal Introduction-Propositional Calculus-Getting Started with Proofs-Methods of Proof-Logic in Proofs-Analysis of Arguments

UNIT II

Relations**:** Relations-Digraphs and Graphs-Matrices-Equivalence Relations and Partitions-The Division Algorithm and Integers Mod p. Induction and Recursion: Loop Invariants-Mathematical Induction-Big-Oh Notation-Recursive Definitions-Recurrence Relations-More Induction-The Euclidean Algorithm.

UNIT III

Counting: Basic Counting Techniques-Elementary Probability-Inclusion-Exclusion and Binomial Methods-Counting and Partitions-Permutations and Combinations, Binomial Coefficients and Identities, Equivalence Relations, Generalized Permutations and Combinations, Generating Functions, Inclusion-Exclusion, Applications of Inclusion-Exclusion-Pigeon-Hole Principle. Algorithms: Introduction-Examples of Algorithms-Analysis of Algorithms-Recursive Algorithms.

UNIT IV

Graphs: Graphs-Paths and Cycles-Edge Traversal Problems-Hamiltonian Cycles and the Traveling Salesperson Problem-A Shortest-Path Algorithm-Representations of Graphs-Isomorphisms of Graphs-Planar Graphs. Trees: Trees-Terminology and Characterizations of Trees-Rooted Trees-Vertex Traversal Problems-Spanning Trees-Minimal Spanning Trees-Binary Trees- Tree Traversals-Decision Trees and the Minimum Time for Sorting - Isomorphism of Trees.

UNIT V

Recursion and Digraphs**:** General Recursion-Depth-First Search Algorithms-Polish Notation-Weighted Trees-Digraphs-Digraphs Revisited-Weighted Digraphs and Scheduling Networks-Digraph Algorithms.

TEXT BOOKS

1. Kenneth A. Ross and Charles R. B. Wright, Discrete Mathematics, Pearson Education, Fifth Edition
2. Richard Johnson Baugh, Discrete Mathematics, Pearson Education, Eighth Edition, 2018

REFERENCES

1. Discrete Mathematics and its Applications (6th edition), Kenneth H. Rosen, Tata McGraw Hill, Bombay, India
2. Discrete Mathematics with Applications Susanna S. Epp, Brooks/Cole 2011
3. Discrete Mathematics an Introduction to Proofs and Combinatorics, Kevin Ferland, Houghton Mifflin Company, 2009.

Semester	I
Subject	ELECTIVE I:LINEAR ALGEBRA
Maximum Marks	CIA-25Marks ESE-75 Marks
Credits/Instruction Hours	3 Credits / 5 Hours
Exam Duration	3 Hours

Objectives

- Learn the elementary concepts and basic ideas involved in matrix theory
- Particular attention is given to canonical forms of linear transformations, diagonalizations of linear transformations, matrices and determinants.
- Applications to linear models and Inner product spaces are also analyzed.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Determine whether a square matrix is diagonalizable, and compute its diagonallization.	K1, K2, K3, K4, K5
CO2	Find the minimal polynomial and the rational forms of a real square matrix	K1, K2, K3, K4, K5
CO3	Compute the eigen values and eigenvectors of a square matrix and determine the dimension of the corresponding Eigen spaces	K1, K2, K3 & K4
CO4	Discuss the kernel and image of linear of a linear transformation in terms of nullity and rank of a matrix.	K1, K2, K3 & K4
CO5	Applications to linear models such as curve fitting, regression etc	K1, K2, K3, K4, K5

Mapping of CO with PO &PSO:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT I

Linear Equations in Linear Algebra**:** Systems of linear equations - Row reduction and Echelon forms - Vector Equations - Matrix equations Ax = b - Solution set of linear systems - Applications of linear systems - Linear Independence - Introduction to linear transformations - The matrix of linear transformation.

UNIT II

Matrix Algebra: Matrix operations - The inverse of a matrix - Characterizations of Invertible Matrices - Partitioned Matrices - Matrix factorizations - Subspaces of R^n -Dimension and Rank.

UNIT III

Vector Spaces: Vector spaces and subspaces - Null spaces, Column spaces and linear transformations - Linearly independent sets: Bases - Coordinate systems - The dimension of a vector space – Rank - Change of Basis.

UNIT IV

Eigenvalues and Eigenvectors**:** Eigenvectors and Eigenvalues - The Characteristic equations – Diagonalization - Eigenvectors and linear transformations - Complex eigenvalues.

UNIT V

Orthogonality and Least Squares**:** Inner product, length and orthogonality - Orthogonal sets - Orthogonal projections - The Gram - Schmidt Process - Least square problems - Applications to linear models - Inner product spaces - Applications of Inner product spaces.

TEXT BOOKS

1. "Linear Algebra and its Applications" by David C. Lay, Steven R. Lay, Judi. J. McDonald, Fifth Ed., 2016 Pearson.
   Unit I: Chapters 1: Sections: 1.1-1.9;
   Unit II: Chapters 2: Sections: 2.1-2.5, 2.7-2.9;
   Unit III: Chapters 4: Sections: 4.1-4.7;
   Unit IV: Chapters 5: Sections: 5.1-5.5
   Unit V: Chapters 6: Sections: 6.1-6.8

REFERENCES

1. Gilbert Strang, Introduction to Linear Algebra, Fifth Edition, 2016

Semester	I
Subject	ELECTIVE I: STATISTICS FOR DATA SCIENCE
Maximum Marks	CIA-25Marks ESE-75 Marks
Credits/Instruction Hours	3 Credits / 5 Hours
Exam Duration	3 Hours

Objectives

- To perform Explanatory data analysis.
- To study the relationship between the features and develop a model.
- To apply statistical techniques and derive factors.
- To perform dimension reduction and feature selection and fine tune the precision of the model

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Concepts of descriptive Statistics and definitions.	K1, K2, K3, K4, K5
CO2	Problems in correlation and regression and its interpretation	K1, K2, K3, K4, K5
CO3	Frame appropriate model and test its significance.	K1, K2, K3 & K4
CO4	Perform Factor analysis and its efficiency	K1, K2, K3 & K4
CO5	Data reduction and feature selection using discriminant analysis.	K1, K2, K3, K4, K5

Mapping of CO with PO &PSO:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT I

Sampling Techniques – Data Classification – Tabulation – Frequency and graphic Representation – Measures of Central Tendency – Measures of Variation – Quartiles and Percentiles– Moments -Skewness and Kurtosis.

UNIT II

Scatter Diagram – Karl Pearson's Correlation Coefficient – Rank Correlation –Correlation Coefficient for Bivariate Frequency Distribution – Regression Coefficients – Fitting of Regression Lines.

UNIT III

Statistical Tests of Significance - Test of significance for mean(s), variance(s), correlation coefficient(s), regression coefficient, based on t, Chi-square and Fdistributions. Applications of Chi-square in test of significance (independence of attributes, goodness off it).

UNIT IV

Introduction to Factor Analysis – Meaning, Objectives and Assumptions – Designing a Factor Analysis Study – Deriving Factors – Assessing Overall Factors – Validation of Factor Analysis

UNIT V

Introduction to Discriminant Analysis – Concepts, Objectives and Applications – Procedure for conducting Discriminant Analysis – Stepwise Discriminant.

TEXT BOOKS

1. Gupta, S. C. and Kapoor, V. K.: "Fundamentals of Mathematical Statistics", Sultan & Chand & Sons, New Delhi, 11th Ed, 2002.
2. Joseph F Hair, William C Black et al , "Multivariate Data Analysis" , Pearson Education,7th edition, 2013.
3. Joseph F Hair, William C Black et al , "Multivariate Data Analysis" , Pearson Education,7th edition, 2013.
4. T. W. Anderson, "An Introduction to Multivariate Statistical Analysis, 3rd Edition", Wiley, 2003.

REFERENCES

1. James D. Miller, "Statistics for Data Science", Packt, 2017.
2. Chatfield C, A. J. Collins, "Introduction to Multivariate Analysis", Springer Nature, 2020.
3. Dawn Iacobucci, "Multivariate Statistics and Marketic Analytics", 2014.

Semester	I
Subject	ELECTIVE II :DIGITAL IMAGE PROCESSING
Maximum Marks	CIA-25 Marks ESE-75 Marks
Credits/Instruction Hours	3 Credits /5Hours
Exam Duration	3 Hours

Objectives

- The main objective is to familiarize the students with the image enhancement techniques and expose them to a broad range of image processing techniques and their applications.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Identify the characteristics and features of images	K1,K2,K3, K4, K5
CO2	Compare the various image restoration and reconstruction techniques for different types of images.	K1,K2,K3, K4, K5
CO3	Analyze the filters like Mean Filters, Statistic Filters and Adaptive Filters for processing various images.	K1,K2,K3&K4
CO4	Assess the role of segmentation models in handling the color images.	K1,K2,K3, K4, K5
CO5	Design an application that uses different concepts of Image Processing techniques.	K1,K2,K3, K4, K5

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT I

Introduction to Image - Processing System: Introduction - Image Sampling - Quantisation - Resolution - Human Visual System - Classification of Digital Images - Image Types - Elements of an Image-Processing System.

UNIT II

Image File Formats - Applications of Digital Image Processing - Intensity Transformations and Spatial Filtering: Background - Basic Intensity Transformation Functions - Histogram Processing - Fundamentals of Spatial Filtering - Smoothing Spatial Filters

UNIT III

Sharpening Spatial Filters: Foundation - Second Derivative for Image Sharpening - Laplacian - Image Restoration and Reconstruction: Model Of Image Degradation/Restoration Process - Noise Models - Periodic Notes.

UNIT IV

Estimation of Noise Parameters - Restoration in the presence of Noise only - Spatial Filtering: Mean Filters - Order - Statistic Filters - Adaptive Filters - Color Image Processing: Color Fundamentals.

UNIT V

Color Models: RGB Color Model - CMY and CMYK Color Models - HIS Color Model – Pseudo color Image Processing**:** Intensity Slicing - Intensity to Color Transformations.

TEXT BOOKS

1. S Jayaraman, S Essakkirajan and T Veerakumar, Digital Image Processing, Tata Mcgraw Hill Education Pvt. Ltd.
2. Rafael C Gonzalez, Richard E Woods 3rd Edition,(2008), Digital Image Processing, Pearson Education.

REFERENCES

1. William K Pratt, (2001), Digital Image Processing, John Willey.
2. A.K. Jain, (1995), Fundamentals of Digital Image Processing, PHI, New Delhi.
3. Chanda Dutta Magundar, (2000), Digital Image Processing and Applications, Prentice Hall of India.

Semester	I
Subject	ELECTIVE II: WEB DATABASE AND INFORMATION SYSTEM
Maximum Marks	CIA- 25 Marks ESE-75 Marks
Credits/Instruction Hours	3 Credits /5Hours
Exam Duration	3 Hours

Objectives

- Aims to provide students with both theoretical knowledge and practical skills necessary to design, develop, and manage web-based databases and information systems.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Students will be able to design effective relational and non-relational database schemas for web applications.	K1,K2,K3, K4, K5
CO2	Develop dynamic, data-driven web applications that interact with databases through server-side code.	K1,K2,K3, K4, K5
CO3	Designing user-friendly, scalable, and secure web-based information systems, ensuring functionality, security, and scalability.	K1,K2,K3&K4
CO4	Students will be able to optimize database queries and ensure the performance of web databases by using indexing, query optimization, and caching techniques.	K1,K2,K3, K4, K5
CO5	Students will be able to implement advanced database features like transactions, concurrency control, stored procedures, and triggers in web applications.	K1,K2,K3, K4, K5

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT I

Overview of databases and information systems- Types of databases (Relational, NoSQL), Web applications and data-driven systems, Role of databases in web applications, Web architecture (Client-server, Web Services, APIs), Web database models and technologies, Client-server architecture for web databases.

UNIT II

Introduction to Relational Database : Relation, Optimization, The Catalog, Base Relvars and Views, Transactions, The Suppliers and Parts Database. Relational Model Concepts, Relational Model, Constraining, Referential Integrity Constraints, Defining Referential Integrity Constraints, Update Operations on Relations, Structured Query Language (SQL), Data Definition Language Commands, Data Manipulation Language Commands, Transaction Control Commands, SQL Command Syntax and Usage.

UNIT III

Introduction and IS in Global Business Today. Global E-Business: How Business Use Information System, IT Infrastructure and Emerging Technologies, Foundations of Business Intelligence, Telecommunications, the internet, and wireless Technology, Securing Information Systems, Enterprise Applications, Knowledge Management, Enhancing Decision Making information gathering, requirement and feasibility analysis and data flow diagram.

UNIT IV

Design and implement data-driven web applications, such as content management systems (CMS), e-commerce platforms, and social media applications. Apply principles of data integrity, security, and error handling in the development of web-based information systems. Understand the lifecycle of web information systems, from planning and analysis to implementation and maintenance.

UNIT V

Web Frameworks for Database Interaction-Overview of popular web frameworks (e.g., Django, Flask, Express, Laravel), MVC (Model-View-Controller) architecture for web applications. ORM (Object-Relational Mapping) and database abstraction layers.RESTful APIs-Introduction to REST (Representational State Transfer),Designing RESTful services for database interaction **,SOAP vs. REST**-Differences between SOAP (Simple Object Access Protocol) and REST,Use cases for SOAP and REST in web-based information systems

TEXT BOOKS

1. "Database System Concepts" by Abraham Silberschatz, Henry F. Korth, and S. Sudarshan

2. "Web Development with Node and Express" by Ethan Brown

REFERENCES

1.."Learning PHP, MySQL & JavaScript" by Robin Nixon

Semester	I
Subject	ELECTIVE II :DATA SCIENCE ETHICS
Maximum Marks	CIA- 25 Marks ESE-75 Marks
Credits/ Instruction Hours	3 Credits / 5 Hours
Exam Duration	3 Hours

Objectives

- Understand the Foundations of Data Ethics in a Data-Driven World.
- Analyze Research Ethics in Data Science and the Ethical Implications of Data Practices.
- Evaluate the Ethical Concerns of Algorithmic Discrimination and Categorical Bias.
- Explore Privacy, Surveillance, and Ethical Data Practices in Various Contexts.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Gain an overview of ethical issues in data-driven organizations, the ethical practice of data science, and the unique challenges posed by big data, along with philosophical frameworks for assessing fairness.	K1, K2, K3, K4, K5
CO2	Understand the ethical implications of the publish-or-perish culture, issues like p-hacking and small sample sizes, informed consent in data surveillance and techniques for ethical data handling.	K1, K2, K3, K4, K5
CO3	Explore ethical concerns regarding price discrimination and algorithmic decision-making in criminal justice, and examine the philosophical challenges related to categorization and perception in social contexts.	K1, K2, K3 & K4
CO4	Delve into ethical considerations specific to health and educational research, including the ethics of data scraping, storage practices, and the implications of mosaic and found data.	K1, K2, K3 & K4
CO5	Investigate contemporary issues in surveillance, including advertising technology and employment practices, while learning about differential privacy and guidelines for ethical data practices.	K1, K2, K3, K4, K5

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT I

Introduction: Overview of ethical issues in data-driven organizations, Overview of data science as an ethical practice, Introduction to the unique ethical challenges of 'big data', Ethical Theory - Philosophical frameworks for assessing fairness, Moving towards contemporary theories of fairness.

UNIT II

Research ethics for data science: Ethical side effects of the publish or perish system: p-hacking and small sample size, The misapplication of informed consent in dataveillance practices, Techniques of data ethics, Getting from data to individuals: Internet traces and Geo finger prints.

UNIT III

Discrimination and algorithms: The ethics of price discrimination, Criminal justice by algorithm, The philosophical challenge of thinking in categories, How humans explain their social worlds through perceptions and statistics, Social processes and the impact of categorical life.

UNIT IV

Data ethics for researchers: Health Research, Educational Research, The ethics of data scraping and storage, Mosaic data, found data, and designed data.

UNIT V

Privacy and Surveillance: Special topics in surveillance: Adtech, Special topics in surveillance: Employment, Differential privacy, Guidance for acting ethically with data.

TEXT BOOKS

1."Data Ethics: The New Competitive Advantage" by Kord Davis and Doug Patterson, 1st Edition, 2019.

2."Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy" by Cathy O'N**eil, 1st Edition, 2016.**

REFERENCES

1."Ethics of Big Data: Balancing Risk and Innovation" by Kord Davis, 1st Edition, 2012.

2."The Ethical Algorithm: The Science of Socially Aware Algorithm Design" by Michael Kearns and Aaron Roth, 1st Edition, 2019.

Semester	II
Subject	CORE IV– NoSQL DATABASE MANAGEMENT
Maximum Marks	CIA-25Marks ESE-75 Marks
Credits/Instruction Hours	5 Credits / 6 Hours
Exam Duration	3 Hours

Objectives

- Grasp the fundamental differences between NoSQL and traditional relational databases, including key concepts like schema flexibility, data models, and horizontal scaling.
- Analyze various NoSQL data models, including key-value, document, column-family, and graph databases, understanding their use cases and advantages.
- Develop skills in designing NoSQL database architectures tailored to specific application needs, considering factors like scalability, performance, and consistency.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand about Database Management System.	K1,K2,K3, K4, K5
CO2	Understand the concept of NoSQL using MongoDB	K1,K2,K3, K4, K5
CO3	Analyze various Query features on NoSQL	K1,K2,K3&K4
CO4	Understand and examine the relationship among data and its operations using MongoDB	K1,K2,K3, K4, K5
CO5	Develop Web applications with No SQL and it's administration.	K1,K2,K3, K4, K5

Mapping of Course Outcomes to Program Outcome:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT-I

Introduction to Management: History of Database Systems. Database System Applications, database System VS file System. Data Models: ER Model, Relational Model and Other Models. Database Languages: DDL, DML. Introduction to the Relational Model – Integrity Constraint Over relations – Enforcing Integrity constraints – Querying relational data – Logical database Design – Introduction to Views – Destroying /altering Tables and Views.

UNIT-II

Introduction to NoSQL

Overview and History of NoSQL, Types of NoSQL Database, The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL, Key Points. Comparison of relational databases to new NoSQL stores.

Introduction to MongoDB: MongoDB, Cassandra use and deployment, Application, RDBMS approach, Challenges NoSQL approach, Key-Value and Document Data Models, Column-Family Stores, Aggregate Oriented Databases.

UNIT-III

Data And Distribution Models

Replication and Sharding, Map-Reduce on databases. Distribution Models, Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication. NoSQL Key/Value databases using MongoDB, Document Databases, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Web Analytics or Real-Time Analytics, Queries against Varying Aggregate Structure.

UNIT-IV

Key-value Databases

NoSQL Key/Value databases using Riak, Key-Value Databases, Key-Value Store Features, Consistency, Transactions, Query Features, Structure of Data, Scaling, Suitable Use Cases, Storing Session Information, User Profiles, Preferences, Shopping Cart Data, Relationships among Data, Multi operation Transactions, Query by Data, Operations by Sets.

UNIT-V

Transactions Management: Transaction Management, NoSQL Transactions - ACID properties, States of Transaction and Transaction State Diagram, Scheduling - Serial, non-Serial and non-Serializable Scheduling. Failure classification, concurrent execution of transaction– problems with concurrent execution, Concurrency control.

TEXT BOOKS

1. Raghuramakrishnan and Johannes Gehrke, "Database Management Systems", 3rd Edition,
TMH, 2006.
2. Sadalage, P. & Fowler, M., NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence. (1st Ed.). Upper Saddle River, NJ: Pearson Education, In, 2012.

REFERENCES

1. Gauravvaish, Getting started with NoSQL , PACKT publishing
2. Redmond, E. & Wilson, J., Seven Databases in Seven Weeks: A Guide to Modern Databases
and the NoSQL Movement (1st Ed.), 2012
3.Raleigh, NC: The Pragmatic Programmers, LLC.

Semester	II
Subject	CORE V– DESCRIPTIVE AND DISCOVERY ANALYTICS
Maximum Marks	CIA-25Marks ESE-75 Marks
Credits/Instruction Hours	5 Credits / 6 Hours
Exam Duration	3 Hours

Objectives

- Gain a comprehensive understanding of analytics concepts, including the differences between descriptive, diagnostic, predictive, and prescriptive analytics.
- Learn techniques for data preprocessing, including data cleaning, transformation, and normalization, to prepare datasets for analysis.
- Master key descriptive statistical measures and techniques, such as measures of central tendency, dispersion, and distribution, to summarize and interpret data.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Demonstrate the ability to analyze and summarize data using descriptive statistics, extracting meaningful insights that inform decision-making.	K1,K2,K3, K4, K5
CO2	Create compelling data visualizations that effectively communicate analytical findings to various stakeholders, using appropriate tools and techniques.	K1,K2,K3, K4, K5
CO3	Perform exploratory data analysis (EDA) to identify patterns, trends, and anomalies in datasets, leading to actionable insights.	K1,K2,K3&K4
CO4	Utilize discovery analytics techniques such as clustering, association rule mining, and anomaly detection to uncover hidden insights in complex datasets.	K1,K2,K3, K4, K5
CO5	Exhibit enhanced critical thinking and problem-solving abilities, applying analytical reasoning to formulate hypotheses and interpret data-driven outcomes.	K1,K2,K3, K4, K5

Mapping of Course Outcomes to Program Outcome:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT - I

Introduction to Descriptive Analytics – Examples - The Role of Descriptive Analytics in Future Data Analysis – An industry Applications - Descriptive Data Collection: Survey Overview - Descriptive Data Collection: Net Promoter Score and Self-Reports - Descriptive Data Collection: Survey Design - Passive Data Collection - Media Planning- Causal Data Collection and Summary.

UNIT - II

Empowering data analysis with Pandas-Packages- The data structure of pandas- Inserting and Exporting Data- Data Cleansing Checking and Filling Missing Data- String Operations- Merging Data- Aggregation operations -Joins – Case Study.

UNIT III

Basics of Discovery Analytics Comparing two groups - Drawing inferences - Independent groups - Dependent groups -Independent groups - Categorical association - Chi-squared test for association - The Chi- squared test - Interpreting the Chi-squared test - Chi-squared test for goodness of fit – An alternative to the Chi-squared test- Case Study.

UNIT IV

Simple and Multiple Regressions - Simple regression - Describing quantitative association - Simple regression – Drawing inferences - Pitfalls in regression - Testing the model - Checking assumptions – Simple regression - Exponential regression - Multiple regression – Model- Tests –
Overall test -Individual tests - Checking assumptions.

UNIT – V

Parametric Tests and Non-Parametric Tests - Basics and One-way ANOVA - Assumptions and F-test - Post-hoc t-tests – Factorial ANOVA - Assumptions and tests - ANOVA and regression - Non-parametric tests - The basics -Comparing groups with respect to mean rank - Several samples - Kruskal-Wallis test.

TEXT BOOKS

1. Data Science for Business: What You Need to Know About Data Mining and Data-Analytic
   Thinking" by Foster Provost and Tom Fawcett.
2. "Practical Statistics for Data Scientists: 50 Essential Concepts" by Peter Bruce and Andrew Bruce.
3. Statistics for Data Science" by James D. Miller

REFERENCES

1. https://www.coursera.org/learn/wharton-customer-analytics
2. http://www.dataversity.net/fundamentals-descriptive-analytics
3. Samir Madhavan, “Mastering Python for Data Science”, Packt, 2015.

Semester	II
Subject	CORE VI Practical II **:** No SQL Database Management Laboratory
Maximum Marks	CIA-40 Marks ESE-60 Marks
Credits/Instruction Hours	4 Credits / 6 Hours
Exam Duration	3 Hours

Objectives

- Provide students with practical experience in installing, configuring, and managing various NoSQL databases (e.g., MongoDB, Cassandra, Redis).
- Enable students to design and implement appropriate data models for different NoSQL database types, including key-value, document, column-family, and graph databases.
- Teach students how to create and manage indexes in NoSQL databases and optimize queries for performance and efficiency.

LIST OF PROGRAMS

1. MongoDB Installation and Configuration in windows.
2. Write a program to create , Insert, update and drop a database in MongoDB
3. Write a program to Creating the Collection in MongoDB on the fly.
4. Write a program creating collection with options before inserting the documents and drop the collection created.
5. MongoDB insert document
    a. Insert Single document.
    b. Insert multiple documents in collection.
6. Querying all documents in jsonformatand querying based on the criteria.
7. MongoDB Update document
    a. Using update() method.
    b. Using save() method
8. MongoDB delete document from a collection
    a. Using remove() method
    b. Using save() method
9. MongoDB projection
10. Limit(), Skip(), sort() methods in MongoDB
11. MongoDB Indexing
    a. Create index in MongoDB
    b. Finding the indexes in a collection
    c. Remove all documents

Semester	II
Subject	ELECTIVE III :REGRESSION ANALYSIS
Maximum Marks	CIA-25Marks ESE-75 Marks
Credits/Instruction Hours	3 Credits / 4 Hours
Exam Duration	3 Hours

Objectives:

- Develop an understanding of regression analysis and model building.
- Provide the ability to develop relationship between variables
- Investigate possible diagnostics in regression techniques
- Formulate feasible solution using regression model for real-life problems.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	To develop in-depth understanding of the linear and nonlinear regression model	K1,K2,K3, K4, K5
CO2	To demonstrate the knowledge of regression modeling and model selection techniques	K1,K2,K3, K4, K5
CO3	To examine the relationships between dependent and independent variables.	K1,K2,K3&K4
CO4	To estimate the parameters and fit a model.	K1,K2,K3, K4, K5
CO5	To investigate possible diagnostics in regression modeling and analysis.	K1,K2,K3, K4, K5

Mapping of CO with PO &PSO:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT 1

Simple Regression Analysis: Introduction to a linear and nonlinear model. Ordinary Least Square methods. Simple linear regression model, using simple regression to describe a linear relationship. Fitting a linear trend to time series data, Validating simple regression model using t, F and p test. Developing confidence interval. Precautions in interpreting regression results.

UNIT II

Multiple Regression Analysis: Concept of Multiple regression model to describe a linear relationship, Assessing the fit of the regression line, inferences from multiple regression analysis, problem of overfitting of a model, comparing two regression model, prediction with multiple regression equation.

UNIT III

Fitting Curves and Model Adequacy Checking: Introduction, fitting curvilinear relationship, residual analysis, PRESS statistics, detection and treatment of outliers, lack of fit of the regression model, test of lack of fit, Problem of autocorrelation and heteroscedasticity. Estimation of pure errors from near neighbors.

UNIT IV

Transformation techniques: Introduction, variance stabilizing transformations, transformations to linearize the model, Box-Cox methods, transformations on the repressors variables, Generalized and weighted least squares, Some practical applications.

UNIT V

Multicollinearity: Introduction, sources of multicollinearity, effects of multicollinearity. Multicollinearity diagnostics: examination of correlation matrix, variance Inflation factors (VIF), Eigen system analysis of X1X. Methods of dealing with Multicollinearity: collecting additional data, model re-specification, and ridge regression.

TEXT BOOKS

1. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, Introduction to Linear Regression Analysis, Third Ed., Wiley India Pvt. Ltd., 2016.
2. Norman R. Draper, Harry Smith; Applied Regression Analysis, WILEY India Pvt. Ltd. New Delhi; Third Edition, 2015.

REFERENCES

1. Johnson, R A., Wichern, D. W., Applied Multivariate Statistical Analysis, Sixth Ed., PHI learning Pvt., Ltd., 2013.
2. Iain Pardoe, Applied Regression Modeling, John Wiley and Sons, Inc, 2012.

Semester	**II**
Subject	**ELECTIVE III :**PROBABILITY AND DISTRIBUTION MODELS
Maximum Marks	CIA-25Marks ESE-75 Marks
Credits/Instruction Hours	3 Credits / 4 Hours
Exam Duration	3 Hours

Objectives

- To incorporate the concepts of probability theory and its applications as the core material in building theoretical ideas along with the practical notion.
- To integrate the intrinsic ideas of preliminary and advanced distributions to correlate with the real-world scenarios.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Develop problem-solving techniques needed to calculate probability and conditional probability	K1,K2,K3, K4, K5
CO2	Derive the expectation and conditional expectation, and describe their properties.	K1,K2,K3, K4, K5
CO3	Understand various types of generating functions used in statistics.	K1,K2,K3&K4
CO4	Describe commonly used univariate discrete continuous probability distributions	K1,K2,K3, K4, K5
CO5	Describe commonly used univariate continuous probability distributions.	K1,K2,K3, K4, K5

Mapping of CO with PO &PSO

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT 1

Probability and Random variables: Introduction – Random Experiments, Empirical basis of probability, Algebra of events, laws of probability; Conditional Probability, Independence, Bayes theorem. One-dimensional Random variable - Discrete and Continuous; Distribution functions and its properties; Bivariate Random Variables - Joint Probability functions, marginal distributions, conditional distribution functions

UNIT II

Mathematical Expectation: Expectation, Variance, and Co-variance of random variables; Conditional expectation and conditional variance; Markov, Holder, Jensen and Chebyshev's Inequality; Kolmogorov theorem; Central Limit Theorem.

UNIT III

Generating Functions: Probability generating function (p.g.f.), moment generating function (m.g.f.), characteristic function (c.f.); Properties and Applications. Probability distributions of functions of random variables: one and two dimensions.

UNIT IV

Discrete Distributions: Bernoulli, Binomial, Poisson, Geometric, Hypergeometric, Negative Binomial, Multinomial distributions and Discrete Uniform distribution - definition, properties and applications with numerical problems.

UNIT V

Continuous Distributions: Uniform, Normal distribution function, Exponential, Gamma, Beta distributions (First and Second kind), Weibull, Cauchy and Laplace distributions, lognormal, logistic, Pareto and Rayleigh distribution functions - definition, properties and applications; concept of truncated distributions.

TEXT BOOKS

1.Sheldon Ross; A First Course in Probability, Pearson, 2014.

2. Parimal Mukhopadhyay; An Introduction to the Theory of Probability, World scientific,
2012.

REFERENCES

1. FetsjeBijma, Marianne Jonker and Aad van der Vaart; Introduction to Mathematical Statistics, Amsterdam University Press, 2018.
2. Krishnamoorthy, K., Handbook of Statistical Distributions with Applications, Chapman & Hall/CRC, 2006.
3. Rohatgi, V.K. and Ebsanes Saleh, A.K. Md., An introduction to Probability and Statistics, 2nd Ed., John Wiley & Sons, 2002.
4. Shanmugam, R., Chattamvelli, R. Statistics for scientists and engineers, John Wiley, 2015.

Semester	II
Subject	ELECTIVE III : DESIGN AND ANALYSIS OF EXPERIMENTS
Maximum Marks	CIA-25Marks ESE-75 Marks
Credits/Instruction Hours	3 Credits / 4 Hours
Exam Duration	3 Hours

Objectives:

- Describe how to design experiments, carry them out, and analyse the data they yield.
- Construct appropriate experimental designs for given problems: sample size determination,

choice of levels of variables, designs with restrictions on randomization, utility functions

for measuring design objectives, use of simulation to characterize properties of designs.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Describe the purpose of robust construction and how it is applied in experimental design.	K1,K2,K3, K4, K5
CO2	To formulate and validate the experimental designs in agricultural, medical, biomedical projects.	K1,K2,K3, K4, K5
CO3	Avails them to fetch the background concepts of Model formulation and validation	K1,K2,K3&K4
CO4	To accomplish research-oriented concepts given for Factorial techniques required for experimental designs	K1,K2,K3, K4, K5
CO5	To accomplish research-oriented concepts given for BIBD techniques required for experimental designs.	K1,K2,K3, K4, K5

Mapping of CO with PO &PSO:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT 1

Basic Principles of Experimental design: Strategy of Experimentation - Applications of Ex Design – Basic Principles – Guidelines for designing experiments.

UNIT II

Basic Designs: Completely Randomized Design (CRD), Randomized Block Design (RBD) Square Design (LSD).

UNIT III

Analysis of Co-variance: Multiple Comparisons – Multiple Range Tests - Analysis of Covaria – Construction of Orthogonal Latin Square.

UNIT IV

Factorial experiments: Factorial experiments - 2^2, 2^3 and 3^2, 3^3 experiments and their analys Fractional replication in Factorial Experiments. Necessity of confounding, Types of confoundi complete and partial confounding (Concept Only).

UNIT V

Balanced Incomplete Block design: Balanced Incomplete Block Design (BIBD) – Types BIBD – Simple construction methods – Concept of connectedness and balancing – Intra Bl analysis of BIBD.

TEXT BOOKS

1.Douglas C. Montgomery, Design and Analysis of Experiments, 9h Edition, John Whiley and Sons, 2017.

REFERENCES

1. Das M.N. and Giri N.C., Design and Analysis of Experiments, 3rd Edition, New Age International (P) Ltd., 2017.
2. John Lawson, Design and Analysis of Experiments with R, 1st Edition, CRC Press, 2015.

Semester	II
Subject	ELCTIVE IV: CYBER SECURITY
Maximum Marks	CIA-25Marks ESE-75Marks
Credits/Instruction Hours	3 Credits /4 Hours
Exam Duration	3 Hours

Objectives

- Understand the fundamental principles of Cyber Security, including key concepts, terminology, and the importance of protecting information assets.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the fundamentals of Cyber Security.	K1,K2,K3, K4, K5
CO2	Identify various types of cyber threats and vulnerabilities.	K1,K2,K3, K4, K5
CO3	Implement security measures and best practices.	K1,K2,K3&K4
CO4	Analyze and respond to security incidents.	K1,K2,K3, K4, K5
CO5	Identify the internet crimes and Network Security Fundamentals	K1,K2,K3, K4, K5

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT I

Introduction, Computer Security, Threats, Harm, Vulnerabilities, Controls, Authentication, Access Control and Cryptography. Web attack: Browser Attacks, Web Attacks Targeting Users, Obtaining User or Website Data, Email Attacks. Network Vulnerabilities: Overview of vulnerability scanning, Open Port / Service Identification, Banner /Version Check, Traffic Probe, Vulnerability Probe, Vulnerability Examples, OpenVAS, Metasploit.

UNIT II

Network Defence Tools: Firewalls and Packet Filters: Firewall Basics, Packet Filter Vs Firewall, How a Firewall Protects a Network, Packet Characteristic to Filter, Stateless Vs Stateful Firewalls, Network Address Translation (NAT) and Port Forwarding. VPN: the basic of Virtual Private Networks. Firewall: Introduction, Linux Firewall, Windows Firewall. Snort: Introduction Detection System.

UNIT III

Web Application Tools:Scanning for web vulnerabilities tools: Nikto, W3af, HTTP utilities - Curl, OpenSSL and Stunnel. Application Inspection tools – Zed Attack Proxy, Sqlmap, DVWA, Webgoat. Password Cracking and Brute-Force Tools: John the Ripper, L0htcrack, Pwdump, HTC-Hydra.

UNIT IV

Introduction to Cyber Crime, law and InvestigationCyber Crimes, Types of Cybercrime, Hacking, Attack vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems Associated with Computer Crime, Introduction to Incident Response, Digital Forensics, Computer Language, Network Language, Realms of the Cyber world.

UNIT V

Internet crime: Recognizing and Defining Computer Crime, Contemporary Crimes, Computers as Targets, Contaminants and Destruction of Data. Firewalls and Packet Filters, password Cracking, Keyloggers and Spyware, Virus and Warms, Trojan and backdoors, Steganography, DOS and DDOS attack, SQL injection, Buffer Overflow, Attack on wireless Networks.

TEXT BOOKS

1. "Cybersecurity Essentials" by Charles J. Brooks, Christopher Grow, and Philip Craig
2. "The Web Application Hacker's Handbook" by DafyddStuttard and Marcus Pinto
3. "Computer Security: Principles and Practice" by William Stallings and Lawrie Brown

REFERENCES

1. NIST Special Publications.
2. "The Art of Deception" by Kevin D. Mitnick.
3. "Cybersecurity for Dummies" by Joseph Steinberg.
4. "Blue Team Handbook: Incident Response Edition" by Don Murdoch.

Semester	II
Subject	ELECTIVE IV DIGITAL FORENSICS
Maximum Marks	CIA-25 Marks ESE-75Marks
Credits/Instruction Hours	3 Credits /4 Hours
Exam Duration	3 Hours

Objectives

- To understand the basic digital forensics and techniques for conducting the forensic examination on different digital devices.
- To understand how to examine digital evidences such as the data acquisition, identification analysis.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the core principles of digital forensics, including key terminology, concepts, and the importance of evidence handling.	K1,K2,K3, K4, K5
CO2	To demonstrate proficiency in using digital forensics tools and software for data recovery, analysis, and reporting.	K1,K2,K3, K4, K5
CO3	Understand the legal and ethical implications of digital forensics, including relevant laws, regulations, and best practices for evidence collection and preservation.	K1,K2,K3&K4
CO4	Develop the ability to produce clear, concise forensic reports that can be understood by both technical and non-technical audiences.	K1,K2,K3, K4, K5
CO5	Analyze real-world case studies to apply theoretical knowledge to practical scenarios, enhancing their critical thinking and problem-solving skills.	K1,K2,K3, K4, K5

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT -I

Computer forensics fundamentals, Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues.

UNIT II

Understanding Computing Investigations – Procedure for corporate High-Tech investigations, understanding data recovery work station and software, conducting and investigations.

UNIT III

Data acquisition- understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions, remote network acquisition tools, other forensics acquisitions tools.

UNIT IV

Processing crimes and incident scenes, securing a computer incident or crime, seizing digital evidence at scene, storing digital evidence, obtaining digital hash, reviewing case.

UNIT V

Current computer forensics tools- software, hardware tools, validating and testing forensic software, addressing data-hiding techniques, performing remote acquisitions, E-Mail investigations- investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics tool.

TEXT BOOKS

1. Warren G. Kruse II and Jay G. Heiser, "Computer Forensics: Incident Response Essentials", Addison Wesley, 2002.
2. Nelson, B, Phillips, A, Enfinger, F, Stuart, C., "Guide to Computer Forensics and Investigations, 2nd ed., Thomson Course Technology, 2006, ISBN: 0-619-21706-5.

REFERENCES

1. Vacca, J, *Computer Forensics, Computer Crime Scene Investigation*, 2nd Ed, Charles River Media, 2005, ISBN: 1-58450-389.

Semester	II
Subject	ELECTIVE IV - BIG DATA SECURITY
Maximum Marks	CIA- 25 Marks ESE-75 Marks
Credits/ Instruction Hours	3 Credits / 4 Hours
Exam Duration	3 Hours

Objectives

- Understand the Fundamentals of Big Data and Its Impact on Modern Analytics.
- Explore Security, Compliance, and Intellectual Property Challenges in Big Data.
- Learn Strategies for Integrating Big Data Analytics into Enterprise Systems.
- Acquire Expertise in Security Analytics Techniques and Applications.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Gain a comprehensive understanding of the significance of big data in contemporary analytics, the evolving nature of data, and the key obstacles organizations face in harnessing its full potential.	K1, K2, K3, K4, K5
CO2	Explore pragmatic approaches to securing big data, including effective data classification, safeguarding analytics processes, navigating compliance requirements, and addressing intellectual property challenges in a big data context.	K1, K2, K3, K4, K5
CO3	Learn strategic methodologies for adopting big data technologies within organizations, standardizing practices, ensuring scalability, promoting data reuse, and establishing robust governance frameworks for effective integration into enterprise ecosystems.	K1, K2, K3 & K4
CO4	Develop a foundational understanding of security analytics, encompassing various analytical techniques, real-world applications, and the challenges associated with intrusion detection and incident response.	K1, K2, K3 & K4
CO5	Delve into advanced methods for analyzing log files and implementing simulation processes to enhance security protocols, fostering a proactive approach to identifying and mitigating security threats within big data environments.	K1, K2, K3, K4, K5

Mapping of Course Outcomes to Program Outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong 2-Medium 1-Low

UNIT I

INTRODUCTION TO BIG DATA

Arrival of analytics - Big Data Reaches Deep - Obstacles Remain - Data Continue to Evolve - Realizing Value - The Case for Big Data - The Rise of Big Data Options - Beyond Hadoop - Big Data Sources Growing

UNIT II

SECURITY, COMPLIANCE, AUDITING & PROTECTION

Pragmatic Steps to Securing Big Data - Classifying Data - Protecting Big Data Analytics - Big Data and Compliance - The Intellectual Property Challenge - Big Data: The Modern Era - Today, Tomorrow, and the Next Day - Changing Algorithms 25

UNIT III

INTEGRATING BIG DATA ANALYTICS INTO THE ENTERPRISE

The Strategic Plan for Technology Adoption - Standardize Practices for Soliciting Business User Expectations - Acceptability for Adoption: Clarify Go/No-Go Criteria - Prepare the Data Environment for Massive Scalability - Promote Data Reuse - Institute Proper Levels of Oversight and Governance - Provide a Governed Process for Mainstreaming Technology Considerations for Enterprise Integration

UNIT IV

SECURITY ANALYTICS I

Introduction to Security Analytics – Techniques in Analytics – Analysis in everyday life – Challenges in Intrusion and Incident Identification – Analysis of Log file – Simulation and Security Process.

UNIT V

SECURITY ANALYTICS II

Access Analytics – Security Analysis with Text Mining – Security Intelligence – Security Breaches

TEXT BOOKS

1. "Data Science from Scratch: First Principles with Python" by Joel Grus, 2nd Edition, 2019.

2. "An Introduction to Statistical Learning" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, 2nd Edition, 2021.

REFERENCES

1."Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python" by Peter Bruce and Andrew Bruce, 1st Edition, 2017.

2."Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy" by Cathy O'Neil, 1st Edition, 2016.

Semester	II
Subject	SEC – I : Descriptive and Discovery Analytics Lab
Maximum Marks	CIA-40 Marks ESE-60 Marks
Credits/Instruction Hours	2 Credits / 4 Hours
Exam Duration	3 Hours

Objectives

- Students will learn to articulate the concept of descriptive analytics, its purpose, and its significance in summarizing historical data to identify patterns and trends.
- Acquire skills in data cleaning techniques to handle missing values, outliers, and inconsistencies in datasets.

LIST OF PROGRAMS

1. Write a program to import and export data files of different data format.
2. Write a program to apply your own or another library's functions to Pandas objects.
3. Write a program to identify and handle missing data values
4. Write a program for data normalization
5. Write a program to convert common standard data format.
6. Write a program to summarize the data
7. Write a program to implement ANOVA.
8. Write a program to implement correlation
9. Write a program to perform various SQL operations using pandas.
10. Write a program to Model Evaluation Using Visualization
11. Write a program to Simple Linear Regression.
12. Write a program to Multiple Linear Regression model
13. Write a program to R-squared and MSE for In-Sample Evaluation
14. Write a program to perform Model Evaluation

Semester	III
Subject	CORE VII: CRYPTOGRAPHY AND NETWORK SECURITY
Maximum Marks	CIA-25Marks ESE-75Marks
Credits/Instruction Hours	5 Credits / 6 Hours
Exam Duration	3 Hours

Objectives

- To understand Cryptography Theories, Algorithms and Systems.
- To understand necessary Approaches and Techniques to build protection mechanisms in order to secure computer networks.
- To know about the malicious software & firewalls.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the fundamentals of networks security, security architecture, threats and vulnerabilities	K1,K2,K3, K4, K5
CO2	Apply the different cryptographic operations of symmetric cryptographic algorithms	K1,K2,K3, K4, K5
CO3	Apply the different cryptographic operations of public key cryptography	K1,K2,K3&K4
CO4	Apply the various Authentication schemes to simulate different applications.	K1,K2,K3, K4, K5
CO5	Understand various Security practices and System security standards	K1,K2,K3, K4, K5

Mapping of Course Outcomes to Program Outcome:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong 2-Medium 1-Low

UNIT I

Introduction - Security trends – Legal, Ethical and Professional Aspects of Security, Need for Security at Multiple levels, Security Policies – Model of network security – Security attacks, services and mechanisms – OSI security architecture – Classical encryption techniques: substitution techniques, transposition techniques, steganography- Foundations of modern cryptography: perfect security – information theory – product cryptosystem – cryptanalysis.

UNIT II

Symmetric Encryption and Message Confidentiality - Symmetric Encryption Principles, Symmetric Block Encryption Algorithms, Stream Ciphers and RC4 ,Chipher Block Modes of Operation, Location of Encryption Devices, Key Distribution. Public-key Cryptography and Message Authentication: Approaches to Message Authentication, Secure Hash Functions and HMAC, Public-Key Cryptography Principles, Public-Key Cryptography Algorithms, Digital Signatures, Key Management.

UNIT III

Authentication Applications - Kerberos, x.509 Authentication Service, Public-Key Infrastructure. Electronic Mail Security: Pretty Good Privacy (PGP), S/MIME. Unit- 4: IP Security - IP Security Over view, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations. Web Security: Web Security Considerations, Secure Socket Layer(SSL) and Transport Layer Security(TLS), Secure Electronic Transaction(SET).Network Management Security: Basic Concepts of SNMP, SNMPv1 Community Facility, SNMPv3.

UNIT IV

IP Security - IP Security Over view, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations. Web Security: Web Security Considerations, Secure Socket Layer(SSL) and Transport Layer Security(TLS), Secure Electronic Transaction(SET).Network Management Security: Basic Concepts of SNMP, SNMPv1 Community Facility, SNMPv3.

UNIT V

Intruders - Intruders, Intrusion Detection, Password Management. Malicious Software: Virus and Related Threats, Virus Countermeasures, Distributed Denial of Service Attacks. Firewalls: Firewall Design Principles, Trusted Systems, Common Criteria for Information Technology Security Evaluation.

TEXT BOOKS

1. Behrouz A. Ferouzan, “Cryptography & Network Security”, Tata Mc Graw Hill, 2007, Reprint 2015.
2. Stallings William, “Cryptography and Network Security - Principles and Practice 2017.
3. William Stallings, “Network Security Essentials Applications and Standards ”Third Edition, Pearson Education, 2008.

REFERENCES

1. Man Young Rhee, “Internet Security: Cryptographic Principles”, “Algorithms And Protocols”, Wiley Publications, 2003.
2. Charles Pfleeger, “Security In Computing”, 4th Edition, Prentice Hall Of India, 2006.
3. Ulysess Black, “Internet Security Protocols”, Pearson Education Asia, 2000.

Semester	III
Subject	CORE VIII: BLOCK CHAIN & CRYPTO CURRENCY FUNDAMENTALS
Maximum Marks	CIA-25Marks ESE-75Marks
Credits/Instruction Hours	5 Credits / 6 Hours
Exam Duration	3 Hours

Objectives

- To decompose a blockchain system's fundamental components, how they fit together and examine a decentralization using blockchain.
- To explain how Cryptocurrency works, from when a transaction is created to when it is considered part of the blockchain.
- To explain the components of Ethereum and programming languages for Ethereum

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the technology components of Blockchain and how it works behind – the scenes	K1,K2,K3, K4, K5
CO2	Be aware of different approaches to developing decentralized applications.	K1,K2,K3, K4, K5
CO3	Understand the Bitcoin and its limitations by comparing with other alternative coins	K1,K2,K3&K4
CO4	Establish deep understanding of the Ethereum model, its consensus model and code execution.	K1,K2,K3, K4, K5
CO5	Understand the architectural components of a Hyperledger and its development	K1,K2,K3, K4, K5

Mapping of Course Outcomes to Program Outcome:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong 2-Medium 1-Low

UNIT I

INTRODUCTION TO BLOCKCHAIN

History of Blockchain – Types of Blockchain – Consensus – Decentralization using Blockchain – Blockchain and Full Ecosystem Decentralization – Platforms for Decentralization.

UNIT II

INTRODUCTION TO CRYPTOCURRENCY

Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Z cash – Smart Contracts – Ricardian Contracts

UNIT III

ETHEREUM

The Ethereum Network – Components of Ethereum Ecosystem – Ethereum Programming Languages: Runtime Byte Code, Blocks and Blockchain, Fee Schedule – Supporting Protocols – Solidity Language.

UNIT IV

WEB AND HYPERLEDGER

Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda

UNIT V

ALTERNATIVE BLOCKCHAINS AND NEXT EMERGING TRENDS

Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.

TEXTBOOKS

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2. Arshdeep Bahga, Vijay Madisetti, "Block chain Applications: A Hands On Approach", 2017.
3. Andreas Antonopoulos, Satoshi Nakamoto, "Mastering Bitcoin", O'Reilly, 2014.

REFERENCES

1. Roger Wattenhofer, "The Science of the Blockchain" CreateSpace Independent Publishing, 2016.
2. A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.
3. Alex Leverington, "Ethereum Programming" Packt Publishing, 2017

Semester	III
Subject	CORE THEORY IX - PREDICTIVE ANALYTICS
Maximum Marks	CIA-25Marks ESE-75 Marks
Credits/Instruction Hours	5 Credits /6 Hours
Exam Duration	3 Hours

Objectives

- Develop proficiency in analyzing large datasets to identify patterns and trends.
- Gain a solid understanding of statistical methods and models used in predictive analytics.
- Learn to build and validate predictive models using techniques such as regression analysis,
  decision trees, and machine learning.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Able to collect, clean, and preprocess large datasets for analysis.	K1,K2,K3, K4, K5
CO2	Demonstrate the ability to build and evaluate various predictive models, including regression, classification, and time series forecasting.	K1,K2,K3, K4, K5
CO3	Students will apply statistical techniques to analyze data and interpret results, including understanding concepts like correlation, causation, and significance.	K1,K2,K3&K4
CO4	Statistical techniques to analyze data and interpret results, including understanding concepts like correlation, causation, and significance.	K1,K2,K3, K4, K5
CO5	Gain proficiency in using analytical tools and programming languages (such as R, Python, or specialized software) for data analysis and model development.	K1,K2,K3, K4, K5

Mapping of Course Outcomes to Program Outcome:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT 1

Introduction to Data Mining Introduction, what is Data Mining- Concepts of Data Mining, Technologies Used, Data Mining Process, KDD Process Model, CRISP – DM, Mining on various kinds of data, Applications of Data Mining, Challenges of Data Mining.

UNIT II

Data Understanding and Preparation Introduction, Reading data from various sources, Data visualization, Distributions and summary statistics, Relationships among variables, Extent of Missing Data. Segmentation, Outlier detection, Automated Data Preparation, Combining data files, Aggregate Data, Duplicate Removal, Sampling DATA, Data Caching, Partitioning data, Missing Values.

UNIT III

Model development & techniques Data Partitioning, Model selection, Model Development Techniques, Neural networks, Decision trees, Logistic regression, Discriminant analysis, Support vector machine, Bayesian Networks, Linear Regression, Cox Regression, Association rules.

UNIT IV

Model Evaluation and Deployment Introduction, Model Validation, Rule Induction Using CHAID, Automating Models for Categorical and Continuous targets, Comparing and Combining Models, Evaluation Charts for Model Comparison, Meta Level Modeling, Deploying Model, Assessing Model Performance, Updating a Model.

UNIT V

Ethics in predictive analytics- Data privacy and security, Bias and fairness in models, Ethical considerations in decision-making. Time series forecasting- Components of time series data, ARIMA model, Seasonality and trends.

TEXT BOOKS

1. Predictive & Advanced Analytic. Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die" by Eric Siegel

REFERENCES

1. An Introduction to Statistical Learning" by Gareth James et al.

Semester	III
Subject	CORE X PRACTICAL III- PREDICTIVE ANALYTICS LAB
Maximum Marks	CIA-40Marks ESE-60Marks
Credits/Instruction Hours	4 Credits /6 Hours
Exam Duration	3 Hours

Objectives

- To build, train, and validate various predictive models using appropriate algorithms (e.g., regression, classification, time series).
- Encourage the use of EDA techniques to visualize data and uncover insights before modelling.
- To equip with skills to evaluate model performance using metrics like accuracy, precision, recall, and ROC curves, and interpret the results effectively.

List of Programs

1. Introduction to SPSS, Sorting File, Split File, Compute File, Recode File and Select Cases
2. Chi- Square Test (Parametric and Non-Parametric Test)
3. Exploratory Factor Analysis
4. Cluster Analysis
5. Logistic Regression
6. Discriminant Analysis
7. Confirmatory Factor Analysis
8. Conjoint Analysis
9. Time Series
10. MANOVA
11. Decision Tree Analysis

Semester	III
Subject	ELECTIVE V – CLOUD ANALYTICS
Maximum Marks	CIA-25Marks ESE-75 Marks
Credits/Instruction Hours	3 Credits / 3 Hours
Exam Duration	3 Hours

Objectives

- Understand the fundamental concepts of cloud computing and its relevance to analytics.
- Learn the design and implementation of scalable analytics solutions using cloud platforms.
- Gain hands-on experience in utilizing cloud-based tools for big data analytics.
- Explore case studies and practical applications of cloud analytics in various domains.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Explain the key concepts and architecture of cloud computing and analytics.	K1,K2,K3, K4, K5
CO2	Apply cloud-based platforms and tools to process and analyze large datasets.	K1,K2,K3, K4, K5
CO3	Design and develop scalable analytics pipelines in cloud environments.	K1,K2,K3&K4
CO4	Evaluate cloud analytics solutions for business and research purposes.	K1,K2,K3, K4, K5
CO5	Demonstrate practical knowledge of using cloud services such as AWS, Azure, or Google Cloud for analytics tasks..	K1,K2,K3, K4, K5

Mapping of Course Outcomes to Program Outcome:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

Unit I

Introduction to Cloud Analytics

Overview of cloud computing: Characteristics, service models (IaaS, PaaS, SaaS), deployment models.-Fundamentals of analytics: Descriptive, predictive, and prescriptive analytics-Introduction to cloud analytics and its applications in data science.

Unit II

Cloud Platforms for Analytics

Overview of cloud service providers: AWS, Microsoft Azure, Google Cloud Platform (GCP)-Key services for analytics: Data storage, processing, and visualization tools-Cost management and optimization strategies in cloud analytics.

Unit III

Big Data and Cloud Integration

Big Data concepts: Hadoop, Spark, and their integration with cloud platforms-Building scalable analytics pipelines in the cloud-Real-time analytics and streaming services (e.g., Apache Kafka, AWS Kinesis).

Unit IV

Security and Governance in Cloud Analytics

Data privacy, security, and compliance in cloud analytics-Access control and authentication mechanisms-Governance strategies for maintaining data integrity.

Unit V

Case Studies and Applications

Case studies in healthcare, finance, marketing, and education-Practical projects using cloud services for analytics tasks-Emerging trends and future directions in cloud analytics.

TEXT BOOKS

1. Rittinghouse, J. W., & Ransome, J. F. (2017). *Cloud Computing: Implementation, Management, and Security*. CRC Press.
2. Hurwitz, J., Kaufman, M., & Halper, F. (2020). *Cloud Computing For Dummies*. Wiley.

REFERENCES

1.Mahmood, Z. (2019). *Cloud Analytics for Industry 4.0*. Springer.

2.Amazon Web Services Documentation (AWS).

Semester	III
Subject	SEC II : DATA MINING AND KNOWLEDGE DISCOVERY
Maximum Marks	CIA-25Marks ESE-75 Marks
Credits/Instruction Hours	2 Credits / 3 Hours
Exam Duration	3 Hours

Objectives

- To provide an introduction to the basic concepts and techniques of data mining and knowledge discovery.
- To equip students with knowledge of pre-processing data, classification, clustering, and association rule mining techniques.
- To enable students to understand practical applications of data mining for real-world decision-making.
- To emphasize the importance of ethical considerations and interpretability in data-driven solutions.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand and explain the fundamental concepts and scope of data mining and knowledge discovery techniques.	K1,K2,K3, K4, K5
CO2	Apply pre-processing techniques to prepare raw data for mining tasks.	K1,K2,K3, K4, K5
CO3	Develop and evaluate classification models to predict outcomes based on historical data.	K1,K2,K3&K4
CO4	Perform clustering and association rule mining to uncover hidden patterns in datasets.	K1,K2,K3, K4, K5
CO5	Assess the ethical implications of data mining and validate models for real-world applications..	K1,K2,K3, K4, K5

Mapping of Course Outcomes to Program Outcome:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

Unit I
Introduction to Data Mining and Knowledge Discovery -Data Mining Process: Problem Definition, Data Selection, Preprocessing, Transformation -Applications and Trends in Data Mining.

Unit II
Data Cleaning, Integration, and Reduction-Handling Missing Data and Outliers-Feature Selection and Dimensionality Reduction Techniques

Unit III
Introduction to Classification-Decision Trees, k-Nearest Neighbors (k-NN), Naïve Bayes-Model Evaluation Metrics: Precision, Recall, F1-Score, Confusion Matrix

Unit IV
Clustering: k-Means, Hierarchical Clustering, DBSCAN-Association Rule Mining: Apriori Algorithm, FP-Growth-Measures for Rule Evaluation: Support, Confidence, Lift

Unit V
Web Mining and Text Mining Basics-Big Data Analytics and Data Warehousing-Ethical Issues in Data Mining: Privacy, Security, and Bias-Model Interpretability and Explainability

TEXT BOOKS

1. Han, J., Kamber, M., & Pei, J. (2012). *Data Mining: Concepts and Techniques*. Morgan Kaufmann.
2. Tan, P., Steinbach, M., & Kumar, V. (2019). *Introduction to Data Mining*. Pearson.

REFERENCES

1.Aggarwal, C. C. (2015). *Data Mining: The Textbook*. Springer.

Semester	IV
Subject	CORE XI – Exploratory Data Analysis
Maximum Marks	CIA- 25 Marks ESE-75 Marks
Credits/ Instruction Hours	5 Credits/ 6 Hours
Exam Duration	3 Hours

Objectives

- Understand the principles, techniques, and objectives of exploratory data analysis (EDA).

- Develop the ability to clean, preprocess, and transform data to make it analysis-ready.
- Learn to identify patterns, relationships, and trends using visualization and statistical
- methods.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Explain the role of EDA in the broader context of data science and its importance in making data-driven decisions.	K1, K2, K3, K4, K5
CO2	Use statistical and visualization techniques to summarize and gain insights from raw datasets..	K1, K2, K3, K4, K5
CO3	Detect, handle, and treat missing or inconsistent data during preprocessing.	K1, K2, K3 & K4
CO4	Analyze datasets of varying sizes and complexities using Python or R, leveraging libraries such as Pandas, NumPy, Matplotlib, and ggplot2.	K1, K2, K3, K4, K5
CO5	Apply EDA techniques to solve real-world problems and effectively communicate insights through reports, dashboards, and presentations	K1, K2, K3, K4, K5

Mapping of Course Outcomes to Program Outcome:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT I

Introduction to Exploratory Data Analysis

Overview of EDA: Definition, purpose, and scope in the data science pipeline- Differentiating EDA from confirmatory data analysis. Types of data: Categorical, numerical, ordinal, and time-series data. Tools and environments for EDA: Introduction to Python and R for data analysis. Overview of key libraries: Pandas, NumPy, Matplotlib, Seaborn, and Plotly in Python; dplyr and ggplot2 in R. Case study: Initial exploration of a public dataset.

UNIT II

Data Cleaning and Preprocessing

Handling missing data: Identifying missing values and patterns. Techniques: Imputation (mean, median, mode), interpolation, and deletion. Data transformations: Normalization, standardization, and log transformations. Encoding categorical variables: One-hot encoding, label encoding. Outlier detection and handling: Z-score, IQR method, and robust scaling techniques.

UNIT III

Data Visualization

Principles of effective data visualization: Choosing the right chart types based on data. Avoiding visualization pitfalls (misleading graphs, overplotting). Univariate visualization: Histograms, boxplots, and density plots. Bivariate visualization: Scatter plots, line charts, bar charts, and heatmaps. Multivariate visualization: Pair plots, 3D visualizations, and parallel coordinate plots.

UNIT IV

Statistical Analysis in EDA

Descriptive statistics: Measures of central tendency: Mean, median, mode. Measures of dispersion: Range, variance, standard deviation, IQR. Correlation and association: Correlation coefficients, covariance, and association measures for categorical data (e.g., Chi-square test). Hypothesis testing: Null and alternative hypotheses, p-values, and confidence intervals..

UNIT V

Applications and Case Studies in EDA

Domain-specific applications: Healthcare: Analyzing patient data for trends and anomalies. Finance: Fraud detection and customer segmentation. Marketing: Customer behavior analysis and campaign performance. Social media: Sentiment analysis and engagement trends. Capstone project: Selecting a dataset from a domain of choice.

TEXT BOOKS

1. Wickham, H., & Grolemund, G. (2017). *R for Data Science*. O'Reilly Media.
2. McKinney, W. (2022). *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython*. O'Reilly Media.
3. Tufte, E. R. (2001). *The Visual Display of Quantitative Information*. Graphics Press.

REFERENCES

1. VanderPlas, J. (2016). *Python Data Science Handbook*. O'Reilly Media.
2. Online resources: Kaggle datasets, Python/R documentation, Tableau community tutorials.

Subject	ELECTIVE VI :GREEN COMPUTING
Marks	CIA- 25 Marks ESE-75 Marks
Credits/ Instruction Hours	3 Credits / 4 Hours
Exam Duration	3 Hours

Objectives

- Understand the Fundamentals and Strategic Goals of Green IT.
- Analyze Green IT Assets and Model Environmentally Friendly Business Processes.
- Evaluate Green Compliance and the Role of IT Virtualization and Recycling.
- Apply Green IT Strategies to Real-World Scenarios through Case Studies.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the basic concepts of Green IT, including the relationship between business, IT, and the environment, carbon footprints, and strategies for environmentally responsible practices.	K1, K2, K3, K4, K5
CO2	Analyze various green assets such as buildings, data centers, and networks, and explore green business process management, enterprise architecture, and green supply chains.	K1, K2, K3, K4, K5
CO3	Learn about the virtualization of IT systems, the role of electric utilities, and innovative practices like telecommuting and materials recycling, all within the context of a Green Grid framework.	K1, K2, K3 & K4
CO4	Examine socio-cultural aspects of Green IT, compliance protocols, standards, and audits, while addressing emergent carbon issues and future technologies in green compliance.	K1, K2, K3 & K4
CO5	Explore real-world applications of Green IT strategies through case studies in various sectors, including homes, hospitals, packaging industries, and telecommunications, focusing on environmentally responsible business strategies.	K1, K2, K3, K4, K5

Mapping of CO with PO &PSO:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong 2-Medium 1-Low

UNIT 1

Fundamentals: Green IT Fundamentals: Business, IT, and the Environment – Green computing: carbon foot print, scoop on power – Green IT Strategies: Drivers, Dimensions, and Goals – Environmentally Responsible Business: Policies, Practices, and Metrics.

UNIT II

Green Assets and Modeling Green Assets: Buildings, Data Centers, Networks, and Devices – Green Business Process Management: Modeling, Optimization, and Collaboration – Green Enterprise Architecture – Environmental Intelligence – Green Supply Chains – Green Information Systems: Design and Development Models.

UNIT III

Grid Framework Virtualization of IT systems – Role of electric utilities, Telecommuting, teleconferencing and teleporting – Materials recycling – Best ways for Green PC – Green Data center – Green Grid framework.

UNIT IV

Green Compliance Socio-cultural aspects of Green IT – Green Enterprise Transformation Roadmap – Green Compliance: Protocols, Standards, and Audits – Emergent Carbon Issues: Technologies and Future.

UNIT V

Case Studies The Environmentally Responsible Business Strategies (ERBS) – Case Study Scenarios for Trial Runs – Case Studies – Applying Green IT Strategies and Applications to a Home, Hospital, Packaging Industry and Telecom Sector.

TEXT BOOKS

1. Green IT: Energy-Efficient Computing and Sustainable Design" by BhuvanUnhelkar, 1st Edition, 2010.
2. Sustainable IT Playbook for Technology Leaders" by Kevin C. Jackson and Scott E. McDonald, 1st Edition, 2021.

REFERENCES

1. Green Computing: Tools and Techniques for Saving Energy, Money, and Resources" by Bud E. Smith, 1st Edition, 2013.

Semester	IV
Subject	ELECTIVE VI :Nature Inspired Computing
Maximum Marks	CIA- 25 Marks ESE-75 Marks
Credits/ Instruction Hours	3 Credits / 4 Hours
Exam Duration	3 Hours

Objectives:

- Understand and explore computational principles inspired by natural systems.
- Develop innovative algorithms like genetic algorithms, ant colony optimization, and swarm intelligence.
- Solve complex real-world problems, including optimization and prediction tasks.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the core principles behind various nature-inspired algorithms, including evolutionary algorithms, swarm intelligence, and neural networks	K1, K2, K3, K4, K5
CO2	Design and implement nature-inspired algorithms to solve optimization and real-world problems in engineering, machine learning, and artificial intelligence.	K1, K2, K3, K4, K5
CO3	Evaluate and compare the performance of different nature-inspired algorithms in terms of efficiency, scalability, and accuracY	K1, K2, K3&K4
CO4	Apply hybrid models and multi-objective optimization techniques to address complex problems in a wide range of domains.	K1, K2, K3, K4, K5
CO5	Critically analyze the strengths, weaknesses, and ethical considerations of nature-inspired computing techniques, particularly in sensitive fields like bioinformatics and data security.	K1, K2, K3, K4, K5

Mapping of CO with PO &PSO:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT I

Introduction to Nature-Inspired Computing**:**

Overview of Nature-Inspired Computing-Natural phenomena influencing computing-Types of nature-inspired models (biological, physical, and social systems)-Introduction to algorithms inspired by nature-Applications and use cases in real-world problems.

UNIT II

Evolutionary Algorithms**:**

Genetic Algorithms (GA): Selection, crossover, mutation, and fitness evaluation-Evolutionary Strategies (ES) and Genetic Programming (GP)-Applications of evolutionary algorithms in optimization, machine learning, and scheduling-Comparison with traditional optimization methods.

UNIT III

Swarm Intelligence:

Introduction to Swarm Intelligence (SI)-Particle Swarm Optimization (PSO)-Ant Colony Optimization (ACO)-Applications of swarm intelligence in routing, network design, and multi-agent systems-Hybrid approaches combining PSO, ACO, and other techniques.

UNIT IV

Artificial Neural Networks (ANNs) and Bio-Inspired Models:

Introduction to Biological Neural Networks-Fundamentals of Artificial Neural Networks (ANNs)-Deep learning and neural architectures inspired by the human brain-Case studies: Image recognition, pattern -recognition, etc.-Connectionism and its applications

UNIT V:

Hybrid and Advanced Nature-Inspired Techniques

Combining nature-inspired techniques (e.g., Genetic Algorithms with Swarm Intelligence)-Multi-objective optimization using evolutionary algorithms-Advanced hybrid methods and co-evolutionary algorithms-Case studies of hybrid models in real-world applications**.**

TEXT BOOKS

1. Natural Computing: An Overview" by Lakhmi C. Jain and Mario Gavrilova
2. "Nature-Inspired Optimization Algorithms" by Xin-She Yang
3. "Biologically Inspired Algorithms for Financial Modelling" by Jonas Mockus

REFERENCES

1."Swarm Intelligence: From Natural to Artificial Systems" by Eric Bonabeau, Marco Dorigo, and Guy Theraulaz

2."Genetic Algorithms in Search, Optimization, and Machine Learning" by David E. Goldberg

3."Nature-Inspired Algorithms for Optimisation" by Raymond Chiong

Semester	IV
Subject	ELECTIVE VI :Sentimental Analysis
Maximum Marks	CIA- 25 Marks ESE-75 Marks
Credits/ Instruction Hours	3 Credits / 4 Hours
Exam Duration	3 Hours

Objectives

- Understand Sentiment Dynamics: Learn the concepts and methodologies for analyzing opinions, emotions, and sentiments expressed in text.
- Design Analytical Models: Develop models and algorithms for extracting sentiment from unstructured data like reviews, tweets, and blogs.
- Classify Sentiments: Implement systems to classify sentiments into positive, negative, or neutral categories.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the fundamentals of sentiment analysis and its applications in real-world scenarios.	K1, K2, K3, K4, K5
CO2	Leverage advanced techniques like deep learning (RNNs, LSTMs) and pretrained models (BERT, GPT) for sentiment analysis.	K1, K2, K3, K4, K5
CO3	Perform aspect-based sentiment analysis (ABSA) and analyze sentiments towards specific aspects of products or services.	K1, K2, K3&K4
CO4	Apply sentiment analysis to various domains, including social media monitoring, customer feedback analysis, and market research.	K1, K2, K3, K4, K5
CO5	Work with popular NLP libraries and tools such as NLTK, Text Blob, VADER, and Hugging Face	K1, K2, K3, K4, K5

Mapping of CO with PO &PSO:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong2-Medium1-Low

UNIT I

Introduction to Sentiment Analysis and Text Mining:

Introduction to sentiment analysis: definition, scope, and Applications-Overview of text mining and natural language processing (NLP)-Preprocessing text data: tokenization, stopword removal, stemming, Lemmatization-Types of sentiment analysis (binary, multi-class, and fine-grained)-Datasets used in sentiment analysis.

UNIT II

Basic Techniques for Sentiment Classification

Traditional text classification methods: Naive Bayes, Support Vector Machines (SVM)-Feature extraction methods: Bag of Words (BoW), Term Frequency-Inverse Document Frequency (TF-IDF)-Sentiment lexicons: AFINN, Senti WordNet-Sentiment polarity classification: positive, negative, neutral-Evaluating sentiment models: accuracy, precision, recall, F1-score.

UNIT III

Advanced Machine Learning Techniques for Sentiment Analysis:

Introduction to deep learning for sentiment analysis-Recurrent Neural Networks (RNNs) and Long Short-Term Memory Networks (LSTMs)-Word embeddings: Word2Vec, GloVe-Pretrained models: BERT, GPT, and their application in sentiment analysis-Handling class imbalance in sentiment data

UNIT IV

Aspect-Based Sentiment Analysis:

Introduction to aspect-based sentiment analysis (ABSA)-Aspect extraction and opinion mining-Fine-grained sentiment analysis: identifying sentiments for specific aspects-Models for ABSA: neural network-based models, attention mechanisms-Applications of ABSA in customer reviews, product feedback, and social media.

UNIT V

Sentiment Analysis in Real-World Applications:

Sentiment analysis in social media-Sentiment analysis for customer feedback and market research-Ethical issues and biases in sentiment analysis-Tools and libraries for sentiment analysis: NLTK, Text Blob, VADER, Hugging Face-Case studies and hands-on project: applying sentiment analysis to a real-world dataset.

TEXT BOOKS

1. "Speech and Language Processing" by Daniel Jurafsky and James H. Martin
2. "Natural Language Processing and Computational Linguistics" by Bhargav Srinivasa-Desikan
3. "Pattern Recognition and Machine Learning" by Christopher M. Bishop

REFERENCES

1. "Sentiment Analysis and Opinion Mining" by Bing Liu
2. "Sentiment Analysis in Social Networks" by Federico Alberto Pozzi, Elisabetta Fersini, Enza Messina, and Bing Liu
3. "Natural Language Processing with Python" by Steven Bird, Ewan Klein, and Edward Loper

Semester	IV
Subject	ELECTIVE VII :GRAPH THEORY AND NETWORK ANALYSIS
Marks	CIA- 25 Marks ESE-75 Marks
Credits/ Instruction Hours	3 Credits / 4 Hours
Exam Duration	3 Hours

Objective:

- Able to formally apply graph – Theoretic terminology and notations.
- Able to apply theoretical knowledge acquired to solve realistic problems in real life.
- To learn the properties of network functions.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand the basic concepts of graph theory.	K1, K2, K3, K4, K5
CO2	Implement the graph theory in real life problems that can be modelled into graphs.	K1, K2, K3, K4, K5
CO3	Apply two-port network analysis in the design and analysis of filter and attenuator networks.	K1, K2, K3&K4
CO4	Identify the properties and characteristics of network functions	K1, K2, K3, K4, K5
CO5	To understand the definitions and properties of filters.	K1, K2, K3, K4, K5

Unit I

Introduction to Graphs

Definitions: Directed and undirected graphs. Hand shaking property and its problems. Real life applications: Applications- Konigsberg bridge problem, Utility problem and travelling salesman problem. Definitions: Walks, trail, paths, Circuits, Cycles, Sub graphs, Induced and Spanning subgraphs, Connected graphs and Complement of a graph-Problems.

UNIT II

Trees:

Definitions: Trees, Spanning trees, Some Properties of trees(no proof). Rooted and binary tree. Finding all the spanning trees of a graph and Spanning trees in a weighted graph. Traversal of Binary Tree, Pre-order and Post-order Traversal. Prefix codes, optimal tree. Cut – sets. Cut – sets in a graph. Fundamental Circuits and Cut – sets, Network Flows. Max- flow Mincut Theorem (Statement only) and problems.

UNIT III

Graph Theoretic Algorithms and Graph theory in Electrical networks:

Computer representation of a graph. Algorithm on spanning trees: Kruskal's and Prim's Algorithm. Shortest path algorithms: Shortest path from a specified vertex to another specified vertex by Dijkstra's algorithm, Shortest path between all pairs of vertices. Warshall's algorithm. Graphs in switching and coding Theory. Contact networks, analysis of contact networks, synthesis of contact networks, Sequential switching networks.

UNIT IV

Two port networks and Filters:

Modeling Two-port networks-application examples-amplifiers, transmission lines, passive filters. Filter terminology: Low pass, high pass, band-pass and band-reject filters. Constant k and m-derived filters -- low pass, high pass, band-pass and band-stop filters -- design--effect of cascading multiple sections. Resistive T, Pi and lattice attenuators.

Unit V

Network Functions & Responses:

Concept of complex frequency, driving point and transfer functions for one port and two port network, poles & zeros of network functions, Restriction on Pole and Zero locations of network function. Impulse response and complete response.

TEXT BOOK

1. Graph Theory with applications to engineering and computer Science, Narasingh Deo, Edition, Printice hall of India Private Limited, 2009. ISBN: 9788120301450
2. Discrete and Combinatorial Mathematics, Ralph P. Grimaldi., 5th Edition , Pearson, 2006, ISBN: 9788177584240
3. K. S. Suresh Kumar, ―Electric Circuit Analysis‖, Pearson Publications, 2013.
4. Ravish R. Singh, "Network Analysis and Synthesis", McGraw-Hill Education, 2013

REFERENCES

1. Graph Theory, Modeling, Applications and Algorithms, Geir Agnarsson and Raymond Greenlaw, 1st Edition, Pearson Education, Inc, New Delhi 2009. ISBN:9780131343848
2. Franklin Kuo, ―Network Analysis and Synthesis‖, 2nd Ed.,Wiley India
3. Van Valkenburg M.E, ―Network Analysis,‖ Prentice Hall India, 2014.

Semester	IV
Subject	ELECTIVE VII- Reinforcement Learning
Maximum Marks	CIA-25 Marks ESE-75 Marks
Credits/Instruction Hours	3 Credits / 4 Hours
Exam Duration	3 Hours

Objectives

- Comprehend the fundamentals of reinforcement learning, including Markov decision processes (MDPs), value functions, policies, and reward structures.
- Develop and implement key RL algorithms such as Dynamic Programming (DP), Monte Carlo methods, Temporal Difference (TD) learning, Q-learning, and Policy Gradient methods.
- Utilize deep learning techniques to enhance reinforcement learning, specifically with Deep Q Networks (DQN), Policy Gradient methods (PPO, TRPO), and Actor-Critic methods.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Formulate real-world problems as reinforcement learning tasks using concepts like states, actions, rewards, and policies.	K1, K2, K3, K4, K5
CO2	Implement and compare classical RL algorithms (e.g., Dynamic Programming, Monte Carlo, Temporal Difference learning, Q-learning, SARSA) and critically analyze their strengths, weaknesses, and performance in different environments.	K1, K2, K3, K4, K5
CO3	Develop deep reinforcement learning models using frameworks like DQN, A3C, PPO, and TRPO, and apply them to complex environments such as video games or robotics.	K1, K2, K3&K4
CO4	Design and apply effective exploration strategies (e.g., ε-greedy, Upper Confidence Bound) and understand the implications of exploration-exploitation trade-offs in RL settings.	K1, K2, K3, K4, K5
CO5	Apply reinforcement learning algorithms to real-world applications such as robotics, autonomous vehicles, finance, and healthcare, while also considering practical challenges (e.g., sample efficiency, reward shaping, and safety).	K1, K2, K3, K4, K5

UNIT I -Introduction to Reinforcement Learning

Overview of RL and its applications. RL problem: agent, environment, state, action, reward. Exploration vs. exploitation, Markov Decision Processes (MDPs)- States, actions, and rewards, Transition dynamics and reward functions, Discount factor and return. Types of reinforcement learning problems (episodic vs. continuing tasks).

UNIT II - Dynamic Programming and Bellman Equations

Dynamic Programming (DP) fundamentals-Policy evaluation, Policy improvement, Policy iteration, Value iteration. Bellman equations for value functions, Solving MDPs using DP techniques, Limitations of DP and when it's applicable.

UNIT III - Monte Carlo Methods

Monte Carlo (MC) methods for solving RL problems- Monte Carlo estimation of value functions, MC control: policy evaluation and improvement, Exploring starts and first-visit vs. every-visit MC methods, On-policy and off-policy learning with Monte Carlo.

UNIT IV - Temporal Difference Learning

Temporal Difference (TD) learning: combining Monte Carlo and dynamic programming-TD(0) and TD(λ), TD prediction: learning from delayed rewards, Q-learning: off-policy learning for optimal action-value functions, SARSA: on-policy learning algorithm.

UNIT V - Function Approximation

Value function approximation-Linear function approximation, Non-linear function approximation (e.g., neural networks), Policy approximation and policy gradient methods, The role of experience replay in function approximation.

TEXT BOOKS

1. "Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto (Main textbook)
2. "Deep Reinforcement Learning Hands-On" by Maxim Lapan (Practical implementation)

REFERENCES

1. "Algorithms for Reinforcement Learning" by Csaba Szepesvári.
2. "Mastering Chess and Shogi by Self-Play with a General Reinforcement Learning Algorithm" by Silver et al.

Semester	IV
Subject	ELECTIVE VII :HIGH PERFORMANCE COMPUTING FOR DATA SCIENCE
Maximum Marks	CIA- 25 Marks ESE-75 Marks
Credits/ Instruction Hours	3 Credits / 4 Hours
Exam Duration	3 Hours

OBJECTIVES

- Understand High Performance Computing (HPC) system architectures and various computational models.
- Learn basics of CUDA programming.
- Apply parallel execution models and methodologies for parallel programming and parallel applications development.
- Design and implement compute intensive applications on HPC platform.

CO1	Understand High Performance Computing (HPC) system architectures and various computational models.	K1, K2, K3, K4, K5
CO2	Learn basics of CUDA programming.	K1, K2, K3, K4, K5
CO3	Apply parallel execution models and methodologies for parallel programming and parallel applications development.	K1, K2, K3&K4
CO4	Design and implement compute intensive applications on HPC	K1, K2, K3, K4, K5
CO5	Evaluate the performance of computer vision systems in various applications, including autonomous vehicles, medical imaging, and augmented reality.	K1, K2, K3, K4, K5

Mapping of CO and PO:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	2	3	2	2	3	2	1	2	3	2
CO2	3	3	2	2	3	2	2	2	2	2
CO3	2	3	1	3	2	2	2	3	3	2
CO4	2	3	3	3	3	2	2	2	2	2
CO5	2	3	3	3	3	1	2	3	3	3

3-Strong 2-Medium 1-Low

UNIT I

Parallel Programming & Computing – Introduction

Era of Computing, Parallel Computing, Multiprocessors and Multicomputer Architectures, Scalar VS Vector Processing, Multivector and Superscalar Machines, Pipelined Processors, SIMD Computers, Conditions of parallelism, Program flow mechanisms, Types of Parallelism – ILP, PLP, LLP, Program Partitioning and scheduling.

UNIT II

Introduction to High Performance Computing

Era of Computing, Scalable Parallel Computer Architectures, towards low-cost computing, Network of Workstations project by Berkeley, Cluster Computing Architecture, Components, Cluster Middleware and SSI, Need of Resource Management and Scheduling, Programming Environments

UNIT III

High Speed Networks & Message Passing

Introduction to High-Speed Networks, Lightweight Messaging Systems, Xpress Transport Protocol, Software RAID and Parallel File systems, Load Balancing Over Networks – Algorithms and Applications, Job Scheduling approaches and Resource Management in Cluster

UNIT IV

CUDA Programming

Introduction to CUDA architecture for parallel processing, CUDA Parallelism Model, Foundations of Shared Memory, Introduction to CUDA-C, Parallel programming in CUDA-C, Thread Cooperation and Execution Efficiency, Constants memory and events, memory management, CUDA C on multiple GPUs, Hashing and Natural Parallelism, Scheduling and Work Distribution, Atomics, Barriers and Progress, Transactional Memory

UNIT V

Open CL Programming and Shared-memory programming

Introduction to OpenCL, OpenCL Setup, Basic OpenCL, Advanced OpenCL. OpenMP: Introduction to OpenMP, Parallel Programming using OpenMP

TEXT BOOKS

1. Rajkumar, High Performance Cluster Computing: Architectures and Systems, Vol. 1 Pearson Education
2. Georg Hager and Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, CRC Press

REFERENCES

1. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw Hill International Editions

Semester	IV
Subject	SEC-III : Advanced Computer Vision
Maximum Marks	CIA-25 Marks ESE-75 Marks
Credits/Instruction Hours	2 Credits / 2 Hours
Exam Duration	3 Hours

Objectives

- Students will understand the concept of computer vision and image processing.
- students will learn to build the model using neural networks and deep learning with its algorithm.
- Students will learn the concept of image analytics, convolutional neural networks, and more.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understanding of the fundamental concepts and techniques used in image classification.	K1, K2, K3, K4, K5
CO2	Implement algorithms for image processing, feature extraction, and object detection.	K1, K2, K3, K4, K5
CO3	Gain expertise in fine-tuning pre-trained models for specific tasks, adjusting hyperparameters, and optimizing performance.	K1, K2, K3&K4
CO4	Students will perform the domain anomaly detection and adaptation using Transfer learning there-trained models, Fine Tuning of the pre-trained models.	K1, K2, K3, K4, K5
CO5	Evaluate the performance of computer vision systems in various applications, including autonomous vehicles, medical imaging, and augmented reality.	K1, K2, K3, K4, K5

UNIT I

Introduction to Computer Vision

Basic computer vision concepts -image filtering, edge detection, feature extraction. Modern computer vision applications - Autonomous driving, robotics, medical imaging. Image Representation and Transformations - Image transformations scaling, rotation, affine transforms, Color spaces (RGB, HSV).

UNIT II

Deep Learning for Computer Vision

Convolutional Neural Networks (CNNs) and their applications in image classification- Advanced CNN architectures- VGG, ResNet, DenseNet, Transfer learning and fine-tuning for specific vision tasks, Object detection (YOLO, SSD).

UNIT III

Image Segmentation

Image segmentation basics: thresholding, clustering - Semantic segmentation (Fully Convolutional Networks, U-Net)- Instance segmentation (Mask R-CNN)- Recent advances in segmentation techniques (Transformer-based models).

UNIT IV

Object Detection and Tracking

Traditional object detection algorithms (Haar cascades, HOG + SVM), Deep learning-based object detection (YOLO, SSD, Faster R-CNN), Multi-object tracking (Kalman Filters, SORT).

UNIT V

3D Vision and Scene Understanding

3D reconstruction (stereo vision, structure from motion), Depth estimation and disparity maps, point clouds, LiDAR, and 3D convolutional networks, Scene parsing and understanding.

TEXT BOOKS

1. "Computer Vision: Algorithms and Applications" by Richard Szeliski.
2. “Deep Learning for Computer Vision" by Rajalingappaa Shanmugamani.
3. "Multiple View Geometry in Computer Vision" by Richard Hartley and Andrew Zisserman.

REFERENCES

1. "Computer Vision: A Modern Approach" by David A. Forsyth and Jean Ponce
2. "Learning OpenCV 4: Computer Vision with Python" by Adrian Kaehler and Gary Bradski
3. "Computer Vision: Models, Learning, and Inference" by Simon J.D. Prince.