TECHNO INDIA UNIVERSITY

WEST BENGAL

B.Sc. (H) in Data Science

SYLLABUS

Program structure (B.Sc. Data Science)

SEMESTER-I

Course Structure of B.Sc. (H) in Data Science							
B.Sc. SEMESTER I							
Type	**Subject Code**	**Subject (Theory)**	**L**	**T**	**P**	**Total Credit**	**Total Marks**
DSC	TIU-UDS-MJ-T11101	Descriptive Statistics	3	0	0	3	100
DSC	TIU-UDS-MJ-T11103	Introduction to Programming in R	2	0	0	2	100
DSC	TIU-UDS-MJ-T11102	Introduction to Database Management System and Data Warehousing	2	0	0	2	100
Interdisciplinary	TIU-UDS-MD-T1101	Mathematics for Data Science I	1	1	0	2	100
AECC:	TIU-UDS-AEC-T1101	Communicative English	2	0	0	2	100
CVA	TIU-UDS-CVA-T1101	Indian society and culture	1	0	0	1	100
Sessional	TIU-UDS-MJ-L11103	Introduction to R Programming& Microsoft Excel (Practical)	2	0	2	4	100
OEC	TIU-UDS-MI-S11101A	Open Elective - I: Introduction to C Programming	0	0	2	2	100
SEC	TIU-UES-SEC-S1101	Entrepreneurship Skill Development (ESD)	0	2	0	2	100
		1st Semester Total				20	900

Paper 1: Descriptive Statistics DSC: Discipline Specific Core (Course)

Course Objective: To enable the students to develop skills to interpret the results of descriptive statistical analysis in a meaningful way, drawing conclusions and making informed decisions based on data.

Course Outcome (CO)
CO1: Understand the fundamental concepts of descriptive statistics and its importance in data analysis. ● Appreciate the role of descriptive statistics in summarizing and organizing data to extract meaningful insights. ● Identify various methods of data collection and their suitability for different research scenarios. ● Classify data into different types (e.g., nominal, ordinal, interval and ratio) and understand their characteristics and implications for analysis
CO2: Create appropriate tabular representations (e.g., frequency tables, contingency tables) to summarize categorical and numerical data effectively. Generate various types of graphs and charts (e.g., histograms, box plots, scatter plots) to visually represent data distributions and relationships.
CO3: Calculate and interpret measures of central tendency (e.g., mean, median, mode) to understand the typical or central value of a dataset. ● Evaluate the strengths and limitations of different measures of central tendency in different scenarios.
CO4: Compute and interpret measures of dispersion (e.g., range, variance, standard deviation) to assess the spread or variability of data. ● Apply measures of dispersion to compare the variability of different datasets and make informed decisions
CO5: · Define moments and understand their significance in describing the shape and distribution of data. ● Calculate skewness and kurtosis coefficients to assess the asymmetry and peakedness of data distributions. ● Interpret skewness and kurtosis values in context and analyse their implications for data analysis and inference. ● Governance Structures and Practices.
CO6: · Understand the concepts of correlation and regression and their applications in analysing relationships between variables. ● Calculate correlation coefficients (e.g., Pearson correlation, Spearman rank correlation) to quantify the strength and direction of linear relationships between variables. ● Perform simple and multiple linear regression analyses to model and predict the relationship between dependent and independent variables.

Course Content:

Unit No.	Unit Title	Topics Covered	Hours Allocated
1	**Introduction to Statistics**	Introduction to Statistics. Data and types of data. Methods of collection of data	4

2	**Data Collection and Representation**	Different methods of collection of data. Representation of data in tabular and graphical format	2
3	**Graphical Representation**	Generate various types of graphs and charts (e.g., histograms, box plots, scatter plots) to visually represent data distributions and relationships.	3
4	**Measure of central tendency and Measures of Dispersion**	Calculate and interpret measures of central tendency (e.g., mean, median, mode) to understand the typical or central value of a dataset. Compute and interpret measures of dispersion (e.g., range, variance, standard deviation) to assess the spread or variability of data	10
5	**Moments, Skewness and Kurtosis**	Define moments and understand their significance in describing the shape and distribution of data.Calculate skewness and kurtosis coefficients to assess the asymmetry and peakedness of data distributions.	9
6	Bivariate Analysis	Bivariate analysis is a statistical method used to examine the relationship between two variables. It helps in understanding how one variable influences another and is commonly used in data analysis, research, and decision-making.	**17**
Total	-	-	**45**

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	1	1	1	2	2	1	3	2
CO2	3	2	1	1	3	2	2	2	2	2
CO3	3	1	2	1	2	2	2	1	2	2
CO4	3	1	2	1	2	3	2	1	2	2
CO5	3	1	2	2	2	2	2	1	2	2
CO6	3	2	3	3	2	2	3	2	2	3
AVG	3.00	1.33	1.83	1.50	2.00	2.17	2.17	1.33	2.17	2.17

Paper 2: Introduction to Programming in R Discipline Specific Core (Course)

Course Objective:

1. To introduce students to the fundamentals of R programming, including syntax, variables, and constants.
2. To develop skills in handling vectors, including creation, accessing elements, and performing arithmetic operations.
3. To enable students to use control structures such as loops and conditional statements for program flow control.
4. To teach functions in R, including argument passing, scope of variables, and recursion.
5. To introduce working with strings, lists, factors, and data frames for data manipulation.
6. To equip students with file handling skills and statistical applications in R, including data visualization.

CO Number	Details
CO1	Understand the fundamentals of R programming, including installation, character sets, constants, and variables.
CO2	Develop skills in working with vectors in R, including vector creation, accessing elements, and performing arithmetic operations.
CO3	Gain proficiency in control statements in R, such as if-else, switch functions, and loop structures for iterative tasks.
CO4	Learn about functions in R, including argument passing, scope of variables, and recursive functions.
CO5	Work with strings, lists, factors, and data frames in R, performing manipulations and data access operations.
CO6	Handle data files and implement statistical applications in R, including creating charts and graphs for data visualization.

COURSE CONTENT:

Unit	Unit Title	Topics Covered	Duration (Hours)

Unit 1	Fundamentals of R Programming	Installing R Studio, features of R, R character set, constants, variables, operators, precedence, and associativity	6
Unit 2	Vectors in R	Creating vectors, accessing elements, operations on vectors, vector arithmetic	6
Unit 3	Control Statements	If statement, If-else statement, Switch function, Loops (repeat, while, for), Break & Next statement	6
Unit 4	Functions in R	Argument types (formal, actual, named), global and local variables, recursive functions	6
Unit 5	Strings, Lists, Factors, and Data Frames in R	String manipulations, creating & merging lists, creating & accessing data frames, arrays	6
Unit 6	Data File Handling in R	Reading & writing data files, handling different file formats	6
Unit 7	Statistical Applications in R	Basic statistical functions, mean, median, standard deviation, probability distributions	6
Unit 8	Charts and Graphs in R	Creating bar charts, histograms, scatter plots, line graphs, box plots	6

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	1	1	1	1	1	1
CO2	3	3	2	2	2	1	3	2	1	2
CO3	2	3	2	2	2	1	3	2	1	2
CO4	2	3	2	3	3	2	3	2	2	2
CO5	1	3	3	3	3	3	3	2	2	2
CO6	1	2	3	3	3	3	3	3	2	3
Average	3	3	2	2	2	2	3	2	2	3

Suggested Readings

1. **Matloff, N. (2011).***The Art of R Programming: A Tour of Statistical Software Design*. No Starch Press.
2. **Wickham, H., & Grolemund, G. (2016).***R for Data Science: Import, Tidy, Transform, Visualize, and Model Data*. O'Reilly Media.
3. **Davies, T. M. (2016).***The Book of R: A First Course in Programming and Statistics*. No Starch Press.
4. **Grolemund, G. (2014).***Hands-On Programming with R: Write Your Own Functions and Simulations*. O'Reilly Media.
5. **Rizzo, M. L. (2008).***Statistical Computing with R*. CRC Press.

Paper 3: Introduction to Database Management System and Data Warehousing DSC: Discipline Specific Core (Course)

Course Objective:

The objective of a Database Management System (DBMS) course or subject is to provide students with a comprehensive understanding of the principles, design, implementation, and management of databases along with the techniques for designing effective database schemas & understanding the lifecycle of database development from requirements analysis to implementation.

CO Number	Details
CO1	Understand the fundamental concepts of databases, including their architecture, different database models, and the relational model, while also gaining knowledge about relational integrity constraints and relational algebra/calculus.
CO2	Demonstrate the ability to define database structures using SQL, construct complex queries, perform data updates, and apply integrity constraints, while customizing query outputs using SQL functions and performing aggregate operations and set operations.
CO3	Apply advanced semantic database design techniques by using Entity-Relationship (E-R) modeling, understanding and creating E-R diagrams, specifying cardinality constraints, and incorporating concepts like weak entities, subclass inheritance, and mapping E-R to relational models.
CO4	Understand and apply database normalization techniques by learning about functional dependencies and various normal forms (1NF, 2NF, 3NF, BCNF, and 4NF), ensuring the design of efficient and non-redundant databases.
CO5	Gain knowledge in transaction processing, understanding the fundamental properties of transactions (ACID properties), concurrency control mechanisms, and the significance of serializability, conflict serializability, and view serializability.
CO6	Understand scheduling concepts in database systems, focusing on recoverable and non-recoverable schedules, cascading rollbacks, and ensuring the consistency and reliability of databases during concurrent transactions.

Course Contents

Unit No.	Unit Title	Topics Covered	Duration (Hours)
1	**Database**	1.1 Introductory concepts	**6**

	Fundamentals	1.2 Databases and information system, An example, usage context	
		1.3 Database system concepts and architecture	
		1.4 ANSI-SPARC architecture, different database models, relational model concepts	
		1.5 Relational integrity constraints language and systems	
		1.6 Relational algebra and relational calculus	
2	**SQL**	2.1 Data Definition in SQL	**6**
		2.2 Queries and update statements	
		2.3 Integrity constraints	
		2.4 SQL functions to customize output	
		2.5 Aggregate queries	
		2.6 Set operations	
3	**Semantic Database Design**	3.1 E-R Modeling concepts	**6**
		3.2 E-R Diagram	
		3.3 Cardinality constraints	
		3.4 Higher-order relationship	
		3.5 Enhanced ER Model (EER)	
		3.6 Weak entity types	
		3.7 Subclass and inheritance	
		3.8 Specialization and Generalization	
		3.9 E-R to relational mapping	
4	**Normalization**	4.1 Normalization	**4**
		4.2 Functional dependency	
		4.3 1NF, 2NF, 3NF, BCNF, 4NF	
5	**Transaction Processing and Concurrency Control**	5.1 Transaction Fundamentals	**8**
		5.2 Concurrency issues, need for transactions	
		5.3 Necessary properties of transaction (ACID properties)	
		5.4 Serializability, Serial Schedules	
		5.5 Conflict serializability	
		5.6 View serializability	
		5.7 Recoverable and non-recoverable schedules	
		5.8 Cascading rollbacks	

CO/PO	PO1:	PO2:	PO3:	PO4:	PO5:	PO6:	PO7:	PO8:	PO9:	PO10:
CO1	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**1**	**2**
CO2	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**3**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**
CO4	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO5	**2**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**3**
CO6	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**
AVERAGE	2	2.17	2.33	2.17	2.00	2.17	2.83	2.17	2.17	2.50

Paper 4: Mathematics for Data Science-I: Interdisciplinary

Course Objectives: The objectives of mathematics in data science are to provide the theoretical foundations and analytical tools necessary for extracting meaningful insights, making predictions, and solving real-world problems using data.

Course Outcomes (COs): After completion of the course, the students shall be able to:

Course Outcome (CO)	Description
CO1	Students will be able to evaluate limits of functions, understand the concept of continuity, and apply these principles to analyse the behaviour of functions in both discrete and continuous contexts
CO2	Students will demonstrate proficiency in differentiating various types of functions, including those involving products and quotients, and will be able to apply differentiation techniques to solve real-world problems
CO3	Students will be able to perform integration of continuous functions, including the use of integration by parts and the evaluation of sums of discrete variables, thereby establishing a strong foundation in integral calculus
CO4	Students will acquire the ability to perform fundamental operations on matrices, including addition, multiplication, and finding the transpose, as well as understanding special types of matrices and their properties
CO5	Students will be able to compute determinants, understand their significance in linear algebra, and find the inverse of matrices, applying these concepts to solve systems of linear equations
CO6	Students will demonstrate an understanding of key theorems in linear algebra, such as the Cayley-Hamilton theorem, and will be able to apply these concepts to analyse the trace and rank of matrices, as well as to solve linear systems using augmented matrices.

Course Content:

Unit No.	Unit Title	Topics Covered	Hours Allocated
1	Differential Calculus	Limits, Differentiation of continuous variable, Differential of discrete variables, Differentiation, Differentiation of product and division	15
2	Integral Calculus	Limit and Sum of discrete variables, Integration of continuous variables, Integration of products, Differentiation, Integration of parts.	15
3	Linear Algebra	Matrix, Determinates, Types of Matrices, Algebra of Matrices, Transpose of a Matrix, Special Types, Differentiation and Integration of Determinants, Inverse of a Matrix, Orthogonal Matrix, Trace and Rank of Matrix, Linear System of Equations, Augmented matrix, Cayley-Hamilton Theorem	15
Total	-	-	**45**

Bloom's Taxonomy:

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	2	1	1	1	2	2	2	2
CO2	2	2	2	2	1	2	3	2	2	3
CO3	2	1	2	1	1	2	3	2	2	3
CO4	1	3	1	2	1	3	2	2	2	3
CO5	2	2	1	2	1	3	3	3	2	3
CO6	2	3	2	3	1	3	3	2	2	3
AVERAGE	**1.83**	**2**	**1.67**	**1.83**	**1**	**2.33**	**2.7**	**2.17**	**2**	**2.83**

SUGGESTED READING:

1 Mathematics for Data Science" by Nathaniel E. L. McHugh
2. Integral Calculus for JEE Main & Advanced by Amit M Agarwal (Arihant).

Paper 5: Communicative English (AECC: Ability Enhancement Compulsory Course)

Course Objective: The objective of this course is to introduce students to the fundamental theory of communication, and different tools and Barriers of communication.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO1	Speak in English language independently and Enhanced Speaking Skills.
CO2	Develop vital communication skills which are integral to their personal, social, and professional interactions.

CO3	Become proficient in professional communication such as interviews, group discussions, office environments, important reading skills as well as writing skills such as memo, notice, report writing, note-taking, etc.
CO4	Strengthened Reading Comprehension and Critical Thinking and Problem-Solving.
CO5	Cultural Awareness and Social Etiquette and Teamwork and Collaboration.
CO6	Confidence in Public Speaking and Use of Technology in Communication.

Course Contents:

Unit	Topic	Subtopics	Session Duration (Hours)
Unit 1	Grammar & Grammatical Focus	Words often confused, One-word substitution, Phrases, Idioms	**2**
		Parts of Speech, Tense, Voice, Clause, Preposition, Degrees of Comparison	**2**
		Synonyms & Antonyms, Analyzing Grammatical Errors, Spelling & Punctuation	**2**
Unit 2	Reading	Vocabulary Building	**1.5**
		Comprehension, Interpretation	**1.5**
		Summarizing	**1**
Unit 3	Writing	Letter Writing – Formal, Informal, Invitations	**2**
		Paragraph Writing, Precise Writing	**1.5**
		Essay Writing	**1.5**
Unit 4	Speaking	Interactive Communication (Introducing Self, Greetings, Conversations)	**2**
		Pronunciation: Stress, Intonation, Clarity	**1.5**
Unit 5	Listening	Understanding Spoken English	**1.5**
		Understanding Formal English	**1.5**
		Listening Exercises	**2**
Total			**20 Hours**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	2	3	2	2	3	1	2
CO2	2	1	1	1	1	3	3	3	2	2
CO3	2	2	1	2	2	2	1	2	2	2
CO4	1	1	1	1	1	2	2	2	1	1
CO5	2	2	2	2	2	1	2	3	2	2
CO6	2	2	1	3	2	1	1	3	1	3
AVERAGE	**1.67**	**1.50**	**1.17**	**1.83**	**1.83**	**1.83**	**1.83**	**2.67**	**1.50**	**2.00**

SUGGESTED READINGS:

- **Effective Communication Skills by Dr. Kulbhushan Kumar.**
- **Communication Skills by Gail Schlicht.**

Paper 6: Indian Society & Culture (CVA: Value Based)

Course Objectives: The objective of this course is to expose students to different aspects of Indian society and culture. Students will develop an understanding of societal and cultural dimensions of the dynamic nature of society and the environment in which they will live and work as professionals as social entrepreneurs. Indian Society and culture helps students to explore the rich diversity of Indian society and culture, including its linguistic, religious, regional, and ethnic diversity.

Course Outcomes (COs): After completion of the course, the students shall be able to:

Course Outcome (CO)	Description
CO1: Understand the historical and cultural evolution of Indian society.	Gaining knowledge of India's historical and cultural development over time.
CO2: Analyze the diversity of Indian society.	Examining the various dimensions of India's social diversity, including caste, class, language, and ethnicity.
CO3: To Understand the linkages among social, cultural and scientific/business environment.	Evaluating the interconnections between society, culture, and economic or scientific advancements.
CO4: Evaluate the role of religion in shaping social structures.	Analyzing how religious beliefs and practices influence societal norms and institutions.
CO5: Examine social issues and contemporary challenges.	Understanding and assessing key social issues such as gender inequality, poverty, and modernization.
CO6: Identify key cultural practices, art forms, and traditions.	Recognizing and appreciating India's diverse artistic, cultural, and traditional heritage.

Course Contents:

Unit No.	Unit Title	Topics Covered	Hours Allocated

1	Literary and Archaeological Sources of Ancient and Medieval Indian History	Literary & Archaeological Sources, Pre-history & Proto-history, Indus Valley Civilization (Origin, Characteristics, Decline, Art & Architecture).	3
2	Aryans and Vedic Period	Aryan Expansion, Vedic Period (Religious & Philosophic Literature), Mahajanapadas, Jainism & Buddhism, Mauryan Empire (Chandragupta, Kautilya, Arthashastra, Asoka, Art & Architecture).	3
3	Post-Mauryan Period	Indo-Greeks, Sakas, Kushanas – Social Conditions, Art, Architecture, Culture & Literature, Early States in Eastern India, Deccan & South India, Satavahanas, Tamil States, Literature & Culture.	3
4	Society, Religion, Culture and Economy of Medieval India	Delhi Sultanate Society, Religion, Culture & Economy, Mughal-Afghan Conflict, Akbar's Consolidation, European Penetration & British Expansion, Social & Cultural Development.	3
5	Fascinating Indian Culture	Traditions & Customs (Greetings, Religious Customs, Festivals, Family & Marriage, Symbols, Cuisine, Clothing, Dance, Epics & Mythology, Martial Arts, Languages).	3
Total	-	-	**15**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	2	1	2	1	3	3	3
CO2	2	1	1	1	1	1	1	3	2	3
CO3	2	2	1	2	2	1	2	2	2	3
CO4	1	1	1	1	1	1	1	3	2	3
CO5	2	2	2	3	2	2	3	2	2	2
CO6	2	2	1	3	2	1	2	2	2	3
AVERAGE	**1.67**	**1.5**	**1.67**	**2**	**1.5**	**1.33**	**1.67**	**2.5**	**2.16**	**2.83**

Practical Paper: Open Elective - I: Introduction to C Programming

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO Number	Details
CO1	Understand fundamental programming concepts, variables, constants, and C tokens.
CO2	Apply knowledge of operators, data types, and control structures.
CO3	Develop programs using loops, functions, recursion, and pointers.
CO4	Implement advanced programming concepts like function pointers and variable scope.
CO5	Apply structured programming techniques using structures, unions, and storage classes.
CO6	Demonstrate problem-solving and debugging skills with real-world programming assignments.

Course Contents:

Unit No.	Unit Title	Topics Covered	Duration (Hours)
1	Introduction to Programming	Introduction to programming, Variables & Constants, C Tokens, Operators, Compilation Process	6
2	Programming Fundamentals	Data Types, Operators, Control Structures, Loops, Tutorials & Assignments	8
3	Advanced Programming	Nested Loops, Functions, Recursion, Function Pointers, Variable Scope	10
4	Programming Applications	Structures, Unions, Storage Classes, Tutorials & Assignments	6

Practical Paper: Introduction to R Programming & Microsoft Excel (Practical)

COURSE OBJECTIVE:

1. Understand the fundamentals of R programming, including installation, syntax, and variables.
2. Develop skills in working with vectors, lists, factors, and data frames.
3. Gain proficiency in control statements such as loops and conditional operations.
4. Learn about functions in R, including recursion and argument passing.
5. Apply data handling techniques, including data file operations and statistical functions.
6. Visualize data using charts and graphs in R for data analysis and insights.

COURSE OUTCOME:

On completion of the course, the student will be able:

CO Number	Details
CO1	Understand the fundamentals of R programming, including installation, syntax, and data types.
CO2	Develop skills in working with vectors, including element access and arithmetic operations.
CO3	Implement control statements such as loops, conditional statements, and switch functions.
CO4	Create and manipulate functions, including argument passing and recursive functions.
CO5	Work with strings, lists, factors, and data frames, performing manipulations and access operations.
CO6	Perform data handling operations and implement statistical applications, including visualizations.

COURSE CONTENT:

MODULE 1:	**Fundamentals of R Programming**	**2Hours**
Installing R, R character set, constants, variables, operators, precedence, and associativity Vectors in R,Creating Vectors, Accessing elements, Operations on vectors, Vector Arithmetic		
MODULE 2:	**Control Statements in R**	**3 Hours**
If statement, If-else, Switch function, Repeat loop, While loop, Break & Next statements		
MODULE 3:	**Functions in R**	**3 Hours**
Formal and actual arguments, Named arguments, Global and Local variables, Recursive functions		
MODULE 4:	**String, List, Factors & Data Frames**	**2 Hours**
Creating strings, String manipulations, Lists, Creating and merging lists, Data frame creation and access		
MODULE 5:	**Data File Handling in R**	**2 Hours**
Data File Handling in R Reading and writing files, Handling data files in R		
MODULE 6:	**Statistical Applications in R**	**2Hour**
Basic statistical analysis and data manipulation techniques		
MODULE	**Charts and Graphs in R**	**2 Hour**

7:		
Creating various charts and graphs for data visualization		
MODULE 8:	**Introduction to Microsoft Excel**	**3 Hours**
Basic Interface and Features, Basic Data Entry and Formatting, Working with Data, Sorting and filtering data, Formulas and Functions, Basic Formulas, SUM, AVERAGE, MIN, MAX, COUNT Relative, Absolute, and Mixed References		
MODULE 9:	**Conditional Formatting, Charts and Graphs, Data Validation, Pivot Tables**	**3 Hours**
Rules, Data Bars, Color Scales, Icon Sets Bar, Line, Pie Charts, Customizing Charts Restricting Input, Drop-down Lists Creating PivotTables, Filtering, Grouping, Summarizing Data		
TOTAL LAB HOURS		**20 Hours**

Books:

1. Lutz, M. (2013). Learning Python (5th ed.). O'Reilly Media.
2. McKinney, W. (2017). Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython (2nd ed.). O'Reilly Media.
3. Grolemund, G. (2014). Hands-On Programming with R: Write Your Own Functions and Simulations. O'Reilly Media.
4. Wickham, H., & Grolemund, G. (2017). R for Data Science: Import, Tidy, Transform, Visualize, and Model Data. O'Reilly Media.
5. Venables, W. N., & Ripley, B. D. (2002). Modern Applied Statistics with S (4th ed.). Springer.

SEMESTER-II

B.Sc. SEMESTER II							
Type	**Subject Code**	**Subject (Theory)**	**L**	**T**	**P**	**Total Credit**	**Total Marks**
DSC	TIU-UDS-MJ-T12101	Probability Theory 1	3	0	0	3	100
DSC	TIU-UDS-MJ-T12102	Advanced Statistics	2	0	0	2	100
DSC	TIU-UDS-MJ-T12103	Introduction to Python Programming	2	0	1	3	100
Interdisciplinary	TIU-UDS-MD-T1201	Financial Accounting-II	2	0	0	2	100
CVA	TIU-UBC-CVA-T1201	Business Ethics and Governance	1	0	0	1	100

Sessional	TIU-UDS-MJ-L12103	Introduction to Python and Programming(Practical)	0	0	3	3	100
AECC	TIU-UDS-AEC-L1201	Soft Skills (Practical)	0	0	2	2	100
OEC	TIU-UDS-MI-L12101	Open Elective - II: Java Programming	0	0	2	2	100
SEC	TIU-UES-SEC-S1201	Entrepreneurship Skill Development (ESD)	0	2	0	2	100
		2nd Semester Total				**20**	**900**

Paper 1: Probability Theory 1 DSC: Discipline Specific Core (Course)

Course Objectives: The course objectives of probability theory aim to provide students with a solid understanding of basic probability concepts, probability distributions, and their applications in various fields.

Course Outcomes (COs): After completion of the course, the students shall be able to:

Course Outcome (CO)	Description
CO1	Students will be able to define and apply fundamental concepts in probability, including methods of counting, axioms of probability, and conditions of statistical independence and dependence. They will also be able to understand and apply Bayes' Theorem and its applications, as well as the Naïve Bayes Classifier.
CO2	Students will develop an understanding of random variables, including discrete and continuous types. They will be able to compute probability mass functions (PMF) and probability density functions (PDF), and calculate expectations and variances of random variables, including special cases for discrete and continuous random variables.
CO3	Students will understand and apply the concept of conditional probability under both statistical independence and dependence, and they will demonstrate proficiency in using Bayes' Theorem and its applications in real-world problems
CO4	Students will gain knowledge of various discrete and continuous probability distributions, including Bernoulli, Binomial, Poisson, Geometric, Negative Binomial, Uniform, Normal (Gaussian), and Exponential distributions. They will be able to apply these distributions to real-life scenarios.
CO5	Students will learn how to compute the expectation and variance of random variables, both in the discrete and continuous cases. They will also understand the properties of expectation and its application to sums of random variables, as well as conditional expectations
CO6	Students will be able to implement the Naïve Bayes Classifier and use it to solve classification problems, understanding the underlying statistical principles and how to apply Bayes' Theorem in machine learning contexts

Course Content:

Unit No.	Unit Title	Topics Covered	Hours Allocated
1	Basics of probability	Methods of counting (combinatorics). Axioms of probability. Probabilities under conditions of statistical independence. Probabilities under conditions of statistical dependence, Baye's Theorem and its applications Naïve Baye's Classifier	10
2	Random Variables and Expectations	Concept of random variables: mapping from real line to probability space. Concept of Discrete and Continuous random variables, PMF, PDF. Distribution function and its properties, Concept of Expectations. Properties of Expectation. Expectation of Random Variables, Expectation of Sums of Random Variables. Expectation of Special Discrete Random Variables, Expectation of Special Continuous Random Variables, Variance, Conditional Expectation, Computing Expectation	20
3	Probability distributions	Discrete random variable: Bernoulli, Binomial, Poisson, geometric and negative binomial distributions Uniform. Normal (Gaussian), and exponential distributions	15
Total	-	-	**45**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	2	1	1	1	2	2	2	1
CO2	3	2	3	1	2	2	3	2	2	2
CO3	3	2	3	2	2	2	3	3	2	2
CO4	3	2	3	1	2	2	3	2	2	1
CO5	3	2	3	1	2	3	3	2	2	1
CO6	2	3	3	3	3	3	3	3	2	2
AVERAGE	**2.66**	**2**	**2.83**	**1.5**	**2**	**2.16**	**2.83**	**2.33**	**2**	**1.5**

SUGGESTED READING:

1. Fundamentals of Mathematical Statistics by S.C. Gupta and V.K. Kapoor.
2. Statistical Methods (Combined) by N.G. Das.
3. Probability and Statistics by G. Balaji.
4. Probability and Statistics by Pearson Publications.

Paper 2: Advanced Statistics DSC: Discipline Specific Core (Course)

Course objective: To introduce the students to asymptotic theory, including concepts such as convergence in probability, convergence in distribution, and almost sure convergence. To make them understand the basic concepts of hypothesis testing, how to construct and use test statistics for different types of data and hypotheses. To study the desirable properties of estimators, such as unbiasedness, consistency, efficiency, and sufficiency. Understand the methods of point estimation, including method of moments, maximum likelihood estimation (MLE), and least squares estimation.

Course Outcomes (COs): After completion of the course, the students shall be able to:

Course Outcomes	**Description**
CO1: Understanding Population, Sample, Parameter, and Statistics:	Define population, sample, parameter, and statistics in the context of statistical inference. Differentiate between population parameters and sample statistics. Sampling and sampling techniques. Recognize the importance of random sampling in obtaining representative samples.
CO2: Sampling Distribution of Statistics	Concept of a sampling distribution and its significance in statistical inference. Distribution of sample statistics (e.g., sample mean, sample proportion) across different samples .Study of standard error as a measure of the variability of sample statistics..
CO3: Large Sample Theory	Introduce the principles of large sample theory and its applications in statistical inference .Understand the conditions under which large sample approximations are valid, .Apply large sample theory to derive confidence intervals and hypothesis tests for population parameters.
CO4: Hypothesis testing and its role in statistical inference	Understand the null hypothesis, alternative hypothesis, significance level, and critical region. Interpretation of p-values and understand their significance in hypothesis testing. Make decisions regarding the rejection or acceptance of the null hypothesis based on calculated test statistics and p-values. Interpret the results of hypothesis tests in the context of the research question and real-world implications. Understand the concepts of statistical power and sample size determination.
CO5: Theory of estimation and its importance in statistical inference	Concepts of point estimation and interval estimation. Define and understand the properties of estimators, including unbiasedness, consistency, sufficiency, and efficiency.
CO6: Methods of Estimation	Introduce various methods of estimation, including method of moments, maximum likelihood estimation, and Bayesian estimation.

COURSE CONTENT:

Unit No.	Unit Title	Topics Covered	Hours Allocated
1	**Sampling Theory**	Selecting a subset (sample) from a larger population to make statistical inferences. It includes different sampling techniques like random sampling, stratified sampling, and systematic sampling to ensure representativeness and minimize errors.	6
2	**Estimation Theory**	Determining population parameters based on sample data. It includes point estimation (single value estimation) and interval estimation (range estimation) while ensuring properties like unbiasedness, consistency, and efficiency.	6
3	**Testing Of Hypothesis**	Making decisions or inferences about population parameters. It involves setting up null and alternative hypotheses, choosing an appropriate test statistic, determining the significance level, and making conclusions based on p-values.	6
4	**Non- Parametric Methods**	Dealing with ordinal data, small samples, or non-normal distributions. Examples include the Wilcoxon rank-sum test and the Kruskal-Wallis test.	6
5	**Analysis of Discrete Data**	Involving statistical techniques for categorical or count data, such as contingency tables, chi-square tests, and logistic regression. It is commonly used in fields like epidemiology, social sciences, and market research.	6
Total	-	-	**30**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	1	1	1	3	3	3	3	2
CO2	3	2	2	2	2	3	3	2	1	2
CO3	3	1	1	1	1	2	2	3	2	3
CO4	3	1	1	1	1	2	2	3	2	3
CO5	3	1	1	1	1	2	2	3	2	3
CO6	3	1	1	1	1	2	2	3	2	3
Average	**2.83**	**1.17**	**1.17**	**1.17**	**1.17**	**2.33**	**2.33**	**2.83**	**2.00**	**2.67**

Suggested Reading:

1. Testing Statistical Hypotheses (Wiley Series in Probability and Statistics) Hardcover – 13 August 1986 by E. L. Lehmann.
2. **An Introduction to Probability and Statistics**– Vijay K. Rohatgi & A.K. Md. Ehsanes Saleh by Wiley Publication.

Paper 3: Introduction to Python Programming DSC: Discipline Specific Core (Course)

Course Objective:

1. Introduce the fundamental concepts of Python programming, including data types, structures, and syntax.
2. Develop skills in conditional statements and loops for controlling program flow.
3. Enhance students' ability to create modular programs using functions and lambda expressions.
4. Equip students with file handling and exception management skills for real-world applications.
5. Introduce object-oriented programming (OOP)concepts such as classes, inheritance, and polymorphism.
6. Develop problem-solving and debugging skills through hands-on coding and projects.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO Number	Details
CO1	Understand Python fundamentals, including data types, structures, and operators.
CO2	Implement program flow control using conditional statements and loops.
CO3	Develop modular programs using functions and lambda expressions.
CO4	Perform file handling operations and manage exceptions in Python.
CO5	Apply object-oriented programming concepts like classes, inheritance, and polymorphism.
CO6	Develop a collaborative Python project demonstrating problem-solving skills.

COURSE CONTENT:

Unit	Unit Title	Topics Covered	Duration (Hours)
Unit 1	Introduction to Python	Python syntax, input/output, data types, string operations, operators	6
Unit 2	Program Flow in Python	Indentation, if-else statements, loops (for, while), break and continue statements	8
Unit 3	Functions and Modules	Function parameters, variable scope, lambda functions, map function	7

Unit 4	File Handling in Python	File handling modes, reading/writing files, exception handling	7
Unit 5	Class and Objects in Python	OOP concepts, polymorphism, inheritance, encapsulation	8
Unit 6	Collaborative Group Project	Implementing real-world Python applications in groups	10

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	1	2	2	1	1	2
CO2	1	3	2	1	2	1	3	1	1	2
CO3	1	3	3	2	2	2	3	2	1	2
CO4	2	2	1	3	2	2	3	1	2	3
CO5	1	3	2	2	1	1	3	1	2	3
CO6	2	2	2	2	3	3	3	3	2	3
Average	2	3	2	2	2	2	3	2	2	3

Reference Books:

1. Matthes, E. (2021). *Python Crash Course: A Hands-On, Project-Based Introduction to Programming (3rd ed.).* No Starch Press.
2. Barry, P. (2016). *Head First Python: A Brain-Friendly Guide (2nd ed.).* O'Reilly Media.
3. Lutz, M. (2013). *Learning Python (5th ed.).* O'Reilly Media.
4. Ramalho, L. (2022). *Fluent Python: Clear, Concise, and Effective Programming (2nd ed.).* O'Reilly Media.
5. Beazley, D., & Jones, B. K. (2013). Python Cookbook: Recipes for Mastering Python (3rd ed.). O'Reilly Media.

Paper 4: Financial Accounting II, Interdisciplinary

Course Objective:

To grasp the essential accounting concepts, assumptions, and principles. Recognize the role of accounting as an information system and its relevance to various users. Gain proficiency in the double-entry system of bookkeeping. Understand the meaning of inventory and the different inventory record systems. Understand the meaning, types, and limitations of financial statements. Develop the ability to analyse financial statements using ratio analysis.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO NO.	COURSE COUTCOME

CO-1	Ability to apply basic accounting concepts, principles, and assumptions in real-world scenarios.
CO-2	Capability to classify and disclose various assets and liabilities. Competence in differentiating between capital and revenue items.
CO-3	Proficiency in the double-entry bookkeeping system and maintaining accurate Financial records. Ability to prepare journals, ledgers, and subsidiary books efficiently.
CO-4	Skill in preparing comprehensive financial statements including trading accounts, profit & loss accounts, and balance sheets with adjustments.
CO-5	Understanding of inventory management systems and accurate inventory valuation methods.
CO-6	Capability to conduct financial statement analysis using various ratios. Ability to understand and interpret the results of financial ratios to make informed business decisions.

COURSE CONTENT:

Unit 1: Conceptual framework of Financial Accounting Statement:

Accounting concepts, assumptions, principles & its users. Systems of Accounting, Forms of business organization. Accounting as an information system. Branches of Accounting.

Unit 2: Structure of Financial Statement

Basic concept relating to Assets, Liabilities, Income & Expenditure. Basic Accounting Standard, Accounting Equation, Classification & Disclosure requirement of assets & liabilities, Capital & Revenue items.

Unit 3: Recording Business Transactions

Introduction to double entry concept of book keeping, Journal, Ledger, subsidiary books, cash book up to Trial Balance.

Unit 4: Completion of Accounting Cycle

Trading, Profit & loss a/c, Balance sheet (with Basic Adjustments)

Unit 5: Inventory

Meaning, Inventory record system, periodic & perpetual, Inventory Valuation.

Unit 6: Financial Statements Analysis

Meaning and types of financial statements; Limitations of financial statements; Objectives and methods of financial statements analysis; Ratio analysis; Classification of ratios – Profitability ratios, turnover ratios, liquidity ratios, turnover ratios; Advantages of ratio analysis; Limitations of accounting ratios.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	0	0	0	1	1	0	2	2	3	0

CO2	1	1	0	1	2	1	2	3	3	1
CO3	1	1	1	2	2	1	3	2	1	1
CO4	2	1	1	3	3	1	3	3	2	1
CO5	2	1	1	2	2	1	3	2	2	1
CO6	2	1	1	3	3	1	3	3	3	1
Average	**1.33**	**0.83**	**0.67**	**2.00**	**2.17**	**0.83**	**2.67**	**2.50**	**2.33**	**0.83**

Suggested Readings

1. **Financial Accounting Volume I by Mukherjee & Mukherjee, Oxford Higher Education**
2. **Financial Accounting by Amitava Bose, Tee Dee**
3. **Financial Accounting Volume I Hanif Mukherjee, Mc Grow Hill.**

Paper 5: Business Ethics and Governance (CVA: Value Based)

Course Objectives: The course objectives of business ethics aim to provide students with a comprehensive understanding of the ethical dimensions of business practices and decisions. These objectives may include Ethical Decision Making, Understanding Ethical Frameworks, Ethical Leadership, Corporate Social Responsibility (CSR), Ethical Challenges in Specific Business Contexts, Legal and Regulatory Compliance, Global and Cross-Cultural Perspectives, Ethical Communication and Transparency.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO No.	Course Outcome
CO1	Understand the fundamental concepts of business ethics and their importance
CO2	Analyse business ethics in various organizational and global contexts
CO3	Evaluate ethical theories and decision-making models in business
CO4	Apply ethical management tools and techniques in corporate settings
CO5	Assess corporate governance and ethical issues in finance and sustainability
CO6	Analyse ethical dilemmas across different business functions and industries. Understand ethical practices in Business Management.

Class No.	Unit/Topic	Subtopics	Session Duration (Hours)
1	Unit 1: Business Ethics Overview	What is Business Ethics?	1
2	Unit 1: Business Ethics Overview	Importance of Business Ethics	1

3	Unit 1: Business Ethics Overview	Business Ethics in Different Organizational Contexts	1
4	Unit 1: Business Ethics Overview	Globalization & Sustainability	1
5	Unit 2: Framing Business Ethics	Corporate Social Responsibility (CSR)	1
6	Unit 2: Framing Business Ethics	Stakeholder Theory & Corporate Accountability	1
7	Unit 2: Framing Business Ethics	Corporate Citizenship	1
8	Unit 3: Ethical Theories	Normative & Descriptive Ethical Theories	1
9	Unit 3: Ethical Theories	Models of Ethical Decision Making	1
10	Unit 4: Business Ethics Management	Role of Agencies & Setting Ethical Standards	1
11	Unit 4: Business Ethics Management	Managing Stakeholder Relations	1
12	Unit 4: Business Ethics Management	Assessing Ethical Performance & Organizing Ethics Management	1
13	Unit 5: Contextualizing Business Ethics	Corporate Governance & Ethical Issues	1
14	Unit 5: Contextualizing Business Ethics	Shareholders & Sustainability	1

15	**Unit 5: Contextualizing Business Ethics**	**Financial Management & Ethics**	**1**
	TOTAL		**15**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	2	3	2	2	3	1	2
CO2	2	1	1	1	1	3	3	3	2	2
CO3	2	2	1	2	2	2	1	2	2	2
CO4	1	1	1	1	1	2	2	2	1	1
CO5	2	2	2	2	2	1	2	3	2	2
CO6	2	2	1	3	2	1	1	3	1	3
AVERAGE	1.67	1.50	1.17	1.83	1.83	1.83	1.83	2.67	1.50	2.00

SUGGESTED READING:

- BUSINESS ETHICS BY SHAILENDRA KUMAR, ALOK KUMAR RAI.
- Ethics for Governance: Reinventing Public Services by Mathur, B. P.

LAB PAPER: Introduction to Python and Programming (Practical)

Course Objectives

This course's objective is to introduce students to the fundamentals of Python programming and enable them to develop problem-solving skills through hands-on coding experience. It is designed to build a strong foundation in Python syntax, data types, program control flow, functions, file handling, and exception management. Through a group project, it also fosters collaboration and application of learned concepts.

By the end of this course, students will be able to:

- Understand and apply basic Python programming concepts, including variables, data types, and operators.
- Implement control flow mechanisms such as conditional statements and loops.
- Define and invoke user-defined functions, including lambda expressions and variable arguments.
- Perform file input/output operations and handle exceptions effectively.
- Develop logical thinking and team collaboration through a practical group-based Python project.

Course Outcomes (COs):

CO No.	Course Outcome (CO)
CO1	Recall and understand the basic syntax, data types, and operators used in Python programming.
CO2	Apply control flow structures like conditionals, loops, and indentation to build logical Python programs.
CO3	Develop and use custom functions, lambda functions, and explore variable scopes in Python.
CO4	Handle file operations using various file modes and implement exception handling in Python.
CO5	Evaluate and debug Python programs using standard error handling techniques.
CO6	Design and implement a group project using Python that integrates multiple concepts learned.

Course Content:

Module No.	Exp. No.	Experiment Name	Course Outcome (CO)
Module 1	1	Write a program to print "Hello, World!" and accept user input using input() function.	CO1
	2	Demonstrate different Python data types (int, float, list, tuple, dict, etc.).	CO1
	3	Perform string operations – slicing, indexing, formatting, and concatenation.	CO1
	4	Use arithmetic, logical, and comparison operators with simple examples.	CO1
	5	Create a simple calculator using input/output and operator functionalities.	CO1
Module 2	6	Write a program using if and if-else statements to check whether a number is even or odd.	CO2
	7	Use for loop to print the multiplication table of a given number.	CO2
	8	Write a program using while loop to calculate factorial of a number.	CO2
	9	Demonstrate use of range(), break, and continue statements with examples.	CO2
	10	Create a number guessing game using conditional and loop statements.	CO2
Module 3	11	Create and call user-defined functions with parameters.	CO3
	12	Demonstrate the use of default, keyword, and variable-length arguments.	CO3

Module No.	Exp. No.	Experiment Name	Course Outcome (CO)
	13	Show the concept of local and global variable scope in functions.	CO3
	14	Use lambda functions with map(), filter(), and reduce() on a list of numbers.	CO3
Module 4	15	Open a file and write content into it, then read the content back.	CO4
	16	Append data to an existing file and display its contents.	CO4
	17	Handle file-related exceptions using try-except-finally.	CO4
	18	Demonstrate general exception handling using user-defined examples.	CO5
Module 5	19	Start group project: Decide problem statement and design logic using flowcharts/pseudocode.	CO6
	20	Final project implementation – integrate modules and present complete Python-based solution.	CO6

Suggested Readings:

1. McKinney, W. (2022). *Python for data analysis: Data wrangling with pandas, NumPy, and Jupyter* (3rd ed.). O'Reilly Media.
2. VanderPlas, J. (2016). *Python data science handbook: Essential tools for working with data*. O'Reilly Media.
3. Zelle, J. M. (2016). *Python programming: An introduction to computer science* (3rd ed.). Franklin, Beedle & Associates.
4. Downey, A. B. (2015). *Think Python: How to think like a computer scientist* (2nd ed.). O'Reilly Media.
5. Lutz, M. (2013). *Learning Python* (5th ed.). O'Reilly Media.
6. Sweigart, A. (2019). *Automate the boring stuff with Python: Practical programming for total beginners* (2nd ed.). No Starch Press.

LAB PAPER: Soft Skills (Practical)

Course Objectives:

1. **Develop Effective Communication Skills**
   - Enhance verbal, non-verbal, and written communication skills for professional and personal interactions.
   - Improve active listening, clarity, and persuasive communication.
2. **Enhance Interpersonal and Teamwork Abilities**
   - Foster teamwork, collaboration, and conflict resolution skills.
   - Build strong interpersonal relationships in diverse environments.
3. **Improve Time Management and Goal-Setting Skills**
   - Learn to prioritize tasks, manage time efficiently, and set realistic goals.
   - Develop strategies to enhance productivity and reduce stress.

4. **Boost Emotional Intelligence and Adaptability**
    - Recognize and manage emotions effectively in professional and social settings.
    - Cultivate adaptability and resilience to navigate challenges.
5. **Master Presentation and Public Speaking Skills**
    - Develop confidence in delivering impactful presentations.
    - Utilize visual aids and audience engagement techniques effectively.
6. **Strengthen Professional Etiquette and Grooming**
    - Understand corporate etiquette, body language, and professional behavior.
    - Learn essential workplace ethics and cultural sensitivity.
7. **Develop Leadership and Decision-Making Skills**
    - Enhance problem-solving abilities and decision-making strategies.
    - Understand leadership qualities and styles for professional growth.
8. **Cultivate Stress Management and Work-Life Balance**
    - Learn techniques to manage stress effectively.
    - Promote a balanced and healthy approach to work and personal life.
9. **Improve Creativity and Critical Thinking**
    - Foster creative thinking and problem-solving skills.
    - Encourage innovation and adaptability in real-life scenarios.
10. **Prepare for Interviews and Career Advancement**

- Develop resume writing, interview techniques, and job readiness skills.
- Engage in mock interviews and group discussions to enhance confidence.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO Number	Description
CO1	Overall understanding of verbal and non-verbal communication skills, including clarity, active listening, and empathy. Develop interpersonal skills such as conflict resolution, teamwork, negotiation, and relationship building.
CO2	Prioritizing tasks, managing time effectively, setting achievable goals, and organizing workload. Adapting to change, overcoming obstacles, and fostering resilience.
CO3	Enhancing emotional intelligence, recognizing and managing emotions effectively, understanding others' perspectives, and building strong interpersonal relationships. Cultivating creativity and innovative thinking.

CO4	Strategies for managing stress, maintaining work-life balance, and promoting well-being. Improving presentation skills including content organization, delivery techniques, and audience engagement.
CO5	Functioning effectively in multi-disciplinary and heterogeneous teams through teamwork, interpersonal relationships, conflict management, and leadership quality.
CO6	Becoming a more effective individual through goal/target setting, self-motivation, and practicing creative thinking.

COURSE CONTENT:

Lecture No.	Unit	Topic	Activities/Content	Duration (Hours)
1	Unit 1	Introduction to Communication Skills	Overview of verbal and non-verbal communication	1
2	Unit 1	Verbal Communication	Speaking exercises, pronunciation drills, role plays	1
3	Unit 1	Non-Verbal Communication	Body language, facial expressions, gestures	1
4	Unit 1	Listening Skills	Active listening exercises, listening comprehension	1
5	Unit 1	Reading Skills	Reading comprehension, skimming, scanning	1
6	Unit 1	Writing Skills	Writing effective paragraphs, structuring content	1

7	Unit 2	Personal Grooming	Basics of professional grooming, dressing etiquette	1
8	Unit 2	Grooming for Interviews	Dos and Don’ts for interviews, confidence building	1
9	Unit 2	Personality Transformation	Self-reflection activities, confidence-building techniques	1
10	Unit 3	Business Correspondence - Letters	Writing business letters: format, tone, structure	1
11	Unit 3	Notices, Memos, and Agenda	Drafting notices, writing memos, setting agendas	1
12	Unit 3	Minutes of Meetings	Structure, key elements, drafting techniques	1
13	Unit 3	E-mail Etiquette	Formal email writing, subject lines, and tone	1
14	Unit 4	Building the Right Attitude	Positive thinking exercises, motivational activities	1
15	Unit 4	Johari Window	Self-awareness exercise using Johari Window	1
16	Unit 4	SWOT Analysis	Individual SWOT analysis, peer feedback	1
17	Unit 4	Understanding Human Behavior	Case studies on behavioral transformation	1

18	Unit 4	Time Management	Prioritization techniques, Eisenhower matrix	1
19	Unit 4	Stress Management	Stress-relief techniques, mindfulness exercises	1
20	Unit 4	Goal Setting	SMART goals, long-term vs short-term planning	1
21	Unit 4	Presentation Skills - Content Organization	Structuring a presentation, storytelling techniques	1
22	Unit 4	Presentation Skills - Delivery Techniques	Voice modulation, body language, audience engagement	1
23	Unit 4	Presentation Skills - Visual Aids	Effective use of PPT, charts, and graphs	1
24	Unit 4	Resume Making	Structuring a resume, writing a cover letter	1
25	Unit 4	Group Discussion Techniques	Mock GD sessions, evaluating communication skills	1
26	Unit 4	Personal Interview Skills	Mock interviews, common interview questions	1
27	Unit 4	Case Studies on Professional Communication	Analyzing workplace communication scenarios	1
28	Unit 4	Public Speaking & Confidence Building	Extempore speeches, overcoming stage fear	1

29	Unit 4	Final Mock Interviews	One-on-one interviews with feedback	1
30	Unit 4	Course Recap & Assessment	Review of key concepts, feedback session	1

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	3	3	2	1	2	3	2	1
CO2	2	3	2	3	2	1	2	2	2	3
CO3	2	3	3	3	2	2	1	3	2	2
CO4	2	2	3	3	2	2	2	2	1	2
CO5	3	2	3	3	2	1	2	3	2	2
CO6	2	3	3	2	2	2	2	2	1	3
AVERAGE	**2.17**	**2.50**	**2.83**	**2.83**	**2.00**	**1.50**	**1.83**	**2.50**	**1.67**	**2.17**

SUGGESTED READING:

- How to Win Friends and Influence People BY Dale Carnegie.

- Soft Skills BY K Alex.

LAB PAPER: Open Elective - II: Java Programming

Course Objective:

This course aims to provide hands-on experience in implementing data structures using Java with an object-oriented programming (OOP) approach. The primary objectives are:

1. **Understand the Fundamentals of OOP in Java**
   - Apply encapsulation, inheritance, polymorphism, and abstraction in data structures.
   - Develop Java programs using classes, objects, and interfaces.
2. **Implement Linear Data Structures**
   - Construct arrays, linked lists (singly, doubly, circular) with Java.
   - Develop stack and queue operations using Java classes and methods.
3. **Develop Non-Linear Data Structures**
   - Implement binary trees, binary search trees (BST), heaps, and graphs using Java.
   - Perform tree traversals, graph algorithms (BFS, DFS), and heap operations.

Course Outcomes (COs):

CO No.	Course Outcome

CO1	Understand fundamental object-oriented programming concepts and their advantages over procedural programming.
CO2	Apply core Java programming constructs, including data types, operators, control structures, and functions.
CO3	Develop object-oriented programs using classes, objects, constructors, and polymorphism.
CO4	Implement Java interfaces, exceptions, and I/O operations for robust application development.
CO5	Utilize collection classes and data structures such as lists, maps, and sets for efficient data manipulation.
CO6	Analyse and implement data structures such as stacks, queues, trees, and sorting algorithms.

Course Contents

Unit No.	Unit Title	Topics Covered	Duration (Hours)
1	Fundamental Concepts of Object-Oriented Programming	Introduction to Objects, Problems with Procedural Programming, Encapsulation, Inheritance, Polymorphism, UML Modelling	8
2	Introduction to Java Programming Language	Hello World, Data Types, Variables, Operators, Control Flow, Classes & Members, Inheritance, Polymorphism, Interfaces, Exceptions, Collection Classes, I/O Classes	12
3	Introduction to Data Structures	Abstract Data Types, Stacks, Queues, Linked Lists, Trees, Sorting Algorithms	10

Suggested Readings:

 Data Structures and Algorithms in Java" – Robert Lafore.

- Great for beginners, with step-by-step explanations of Java data structures.

 "Data Structures and Algorithm Analysis in Java" – Mark Allen Weiss

- Focuses on algorithm efficiency and in-depth analysis of data structures.

 "Introduction to Java Programming and Data Structures" – Y. Daniel Liang

- Covers both Java basics and data structures with real-world applications.

 "Thinking in Java" – Bruce Eckel.

- A detailed guide to Java's OOP features and best practices.

SEMESTER-III

Course Structure of B.Sc. (H) in Data Science							
B.Sc. SEMESTER III							
Type	**Subject Code**	**Subject (Theory)**	**L**	**T**	**P**	**Total Credit**	**Total Marks**
DSC	**TIU-UDS-MJ-T21201**	**Probability Theory and Bayesian Statistics**	**3**	**0**	**0**	**3**	**100**
DSC	**TIU-UDS-MJ-T21202**	**Machine Learning and Deep Learning**	**3**	**0**	**0**	**3**	**100**
DSC	**TIU-UDS-MJ-T21203**	**Packages in Python and Data processing**	**3**	**0**	**0**	**3**	**100**
Interdisciplinary	**TIU-UDS-MD-T2101**	**Mathematics for Data Science - II**	**2**	**1**	**0**	**3**	**100**
CVA	**TIU-UDS-CVA-T2101**	**Marketing Analytics**	**2**	**0**	**0**	**2**	**100**
Sessional	**TIU-UDS-AEC-S2101**	**Packages in python programming and Data processing**	**0**	**0**	**2**	**2**	**100**
OEC	**TIU-UDS-MI-S21201A**	**Open Elective - III: Data Processing and EDA in Microsoft Power BI**	**0**	**0**	**2**	**2**	**100**
SEC	**TIU-UES-SEC-S2101**	**Entrepreneurship Skill Development**	**0**	**2**	**0**	**2**	**100**
		3rd Semester Total				**20**	**900**
		3rd Semester Total				**20**	**900**

Paper 1: Probability Theory and Bayesian Statistics1 DSC: Discipline Specific Core (Course)

Course Objective: Studying probability and Bayesian statistics equips individuals with essential tools for reasoning under uncertainty, making informed decisions, and drawing reliable conclusions from data.

Course Outcomes (COs): After completion of the course, the students shall be able to:

Course Outcomes

CO1	Tools for studying discrete random variables, often used to find moments. Finding moments of random variables, both discrete and continuous. Provide information about higher moments and are useful in analysing large deviations.
CO2	Understanding the joint behavior of multiple random variables. Characteristics and properties of independent random variables. Techniques for calculating the distributions of sums of independent random variables. Understanding conditional probabilities and distributions. Handling joint distributions in both discrete and continuous settings. Techniques for analyzing order statistics and deriving marginal distributions. Understanding conditional expectations and their properties.
CO3	Bivariate Normal Distribution and its properties
CO4	Tools for bounding probabilities and moments. Understanding different types of convergence in probability. Statement and applications of the law of large numbers. Understanding and applying the central limit theorem. Additional inequalities useful in probability and statistics. Applications and exercises related to limit theorems.
CO5	Conceptual understanding of stochastic processes and their components. Analysing stochastic processes in different settings. Characteristics and properties of Poisson processes. Understanding the Markov property and its implications. Understanding Markov chains and Markov jump processes.
CO6	Overview of Bayesian statistics and its principles. Understanding and applying Bayes' theorem for updating beliefs. Concepts and characteristics of prior and posterior distributions. Techniques for deriving posterior distributions in simple cases. Understanding loss functions and using them to derive Bayesian estimates of parameters.

Course Content:

Unit No.	Unit Title	Topics Covered	Hours Allocated
1	Study of Discrete random variables	Study of discrete random variables, moments, and large deviations analysis.	4
2	Study of multiple random variables:	Analysis of multiple random variables, joint distributions, order statistics, and conditional expectations.	4
3	Bivariate Normal Distribution and its properties	Study of bivariate normal distribution and its properties.	5
4	Tools for bounding probabilities and moments	Probability bounds, convergence types, law of large numbers, and	6

		central limit theorem applications.	
5	Conceptual understanding of stochastic processes and their components.	Understanding stochastic processes, Poisson processes, and Markov chains.	9
6	Understanding of Bayesian statistics and its principles	Bayesian statistics, prior/posterior distributions, and Bayesian estimation techniques	**17**
Total	-	-	**45**

COs \ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	1	1	1	1	2	2	1	3	2
CO2	3	2	1	1	3	2	2	2	2	2
CO3	3	1	2	1	2	2	2	1	2	2
CO4	3	1	2	1	2	3	2	1	2	2
CO5	3	1	2	2	2	2	2	1	2	2
CO6	3	2	3	3	2	2	3	2	2	3
Average :	3.00	1.33	1.83	1.50	2.00	2.17	2.17	1.33	2.17	2.17

Suggested Reading:

1. Fundamentals of Mathematical Statistics by S.C Gupta, V.K Kapoor, Sultan Chand Publication
2. Introduction to Mathematical Probability by J.V Uspensky , by Mc Graw Hill Publication
3. Stochastic Processes: Modelling and Simulation by D.N Shanbag and C.R Rao

Paper 2: Machine Learning and Deep Learning DSC: Discipline Specific Core (Course)

Course Objective: Develop a solid understanding of the fundamental concepts of machine learning (ML) and deep learning (DL) including supervised learning, unsupervised learning , reinforcement learning & understand the principles of neural networks, deep learning architectures and training algorithms.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO Number	**Details**
CO-1	Understand the fundamental concepts of machine learning, including different learning approaches, supervised and unsupervised learning, prediction, and error analysis.

CO-2	Gain knowledge of basic machine learning algorithms such as Naïve Bayes, Perceptron, K-Means, K-Medoids, Hierarchical Clustering, and Density-based clustering.
CO-3	Develop an understanding of classification techniques, including binary and multiclass classification, regression models, decision trees, regularization methods, and advanced classifiers such as Support Vector Machines (SVM) and Relevance Vector Machines (RVM).
CO-4	Explore deep learning concepts, including neural networks, activation functions, optimization techniques, gradient descent, multilayer perceptrons, and backpropagation learning using frameworks like TensorFlow and Keras.
CO-5	Apply machine learning and deep learning techniques to signal processing tasks, including Fast Fourier Transform (FFT), Convolutional Neural Networks (CNNs), and impulse/ramp function analysis.
CO-6	Implement and evaluate machine learning and deep learning models for real-world applications, focusing on improving performance, generalization, and computational efficiency.

Course Contents:

Unit	Unit Title	Topics Covered	Duration (Hours)
I	**Introduction**	What is machine learning, Learning Approaches, Supervised Learning, Prediction, Unsupervised Learning, Error Analysis	6
II	**Basic Algorithm**	Naïve Bayes, Nearest Neighbor Estimator, A Simple Classifier, Perceptron, K-Means, K-Medoids Clustering, Hierarchical Clustering, Density-Based Clustering	8
III	**Classification**	Binary Classification and Multiclass Classification, Linear Regression Analysis, Multiple Linear Regression, Ridge, Lasso, and Polynomial Regression, Logistic Regression, Rule-Based Decision Tree, Overfitting, Underfitting, Pruning, Multiclass Classification Training & Testing, Regularization for Logistic Regression, Support Vector Machine (SVM), Relevance Vector Machine (RVM), RVM vs. SVM	10

IV	**Deep Learning**	Introduction to Deep Learning, Bayesian Learning, Decision Surfaces, Activation Functions (with TensorFlow and Keras), Linear Classifiers, Linear Machines with Hinge Loss, Optimization Techniques, Gradient Descent, Batch Optimization, Introduction to Neural Networks, Multilayer Perceptron, Back propagation Learning	10
V	**Signal Processing**	Signal Processing and Fast Fourier Transform (FFT), Convolutional Neural Networks (CNNs), Impulse Function, Ramp Function	6

COs / POs	**PO 1**	**PO2**	**PO3**	**PO 4**	**P O5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO-1:	**3**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**3**
CO-2:	**3**	**3**	**3**	**2**	**-**	**2**	**-**	**-**	**-**	**3**
CO-3:	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**-**	**3**
CO-4:	**2**	**3**	**3**	**3**	**-**	**-**	**2**	**1**	**-**	**3**
CO-5:	**3**	**3**	**3**	**3**	**-**	**3**	**3**	**1**	**-**	**3**
CO-6:	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**3**
AVERAGE	2.83	2.83	3.00	2.67	2.00	2.50	2.50	1.25	2.00	3.00

Suggested Reading:

1. **Pattern Recognition and Machine Learning** – *Christopher M. Bishop*
2. **Machine Learning: A Probabilistic Perspective** – *Kevin P. Murphy*
3. **Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow** – *Aurélien Géron*
4. **The Hundred-Page Machine Learning Book** – *Andriy Burkov*
5. **Python Machine Learning** – *Sebastian Raschka & Vahid Mirjalili*
6. **An Introduction to Statistical Learning** – *Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani*
7. **Applied Predictive Modeling** – *Max Kuhn & Kjell Johnson*
8. **Machine Learning for Absolute Beginners** – *Oliver Theobald.*

Paper 3: Packages in python and Data Processing DSC: Discipline Specific Core (Course)

Course Objective:

1. To comprehensively understand Python packages for scientific computing, data analysis, and visualization.
2. To enable students to manipulate, analyze, and visualize large datasets efficiently.
3. To introduce students to machine learning applications using Python libraries.
4. To develop expertise in using NumPy, Pandas, Matplotlib, SciPy, and Scikit-Learn.
5. To equip students with the skills to integrate Python libraries for real-world data science applications.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO Number	Details
CO1	Master NumPy for efficient statistical and mathematical computations.
CO2	Utilize Pandas for data manipulation, filtering, and analysis.
CO3	Create insightful visualizations using Matplotlib.
CO4	Apply SciPy for scientific computing and mathematical problem-solving.
CO5	Implement machine learning techniques using Scikit-Learn.
CO6	Integrate Python libraries for comprehensive data science applications.

COURSE CONTENT:

Unit	Unit Title	Topics Covered	Duration (Hours)
Unit 1	NumPy	Arrays, Multi-Dimensional Arrays, Data Types, Random Number Generation, Matrix Operations	6
Unit 2	Pandas	Series, DataFrame, Importing/Exporting CSV, GroupBy, Describe, Info, Iloc/Loc, Filtering, Slicing	8
Unit 3	Matplotlib	Line Plot, Scatter Plot, Histogram, Boxplot, Subplots, Pie Charts	7
Unit 4	SciPy	Constants, Optimizer, Parse Data, Graphs, Statistical Computations	7
Unit 5	Scikit-Learn	Dimensionality Reduction, Data Pre-Processing, Model Selection, Classification, Clustering	8
Unit 6	Comprehensive Data Science Applications	Integrating Multiple Libraries, Real-World Case Studies, Project-Based Learning	9

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	2	1	2	3
CO2	3	3	2	1	2	3	2	2	2	3
CO3	2	2	2	1	3	2	2	3	2	2
CO4	3	3	2	2	2	3	3	1	2	3

CO5	2	3	3	3	2	3	3	1	2	3
CO6	3	3	3	3	3	3	3	2	3	3
Average	3	3	2	2	2	3	3	2	2	3

Suggested Readings:

1. Matthes, E. (2021). Python Crash Course: A Hands-On, Project-Based Introduction to Programming (3rd ed.). No Starch Press.
2. Barry, P. (2016). Head First Python: A Brain-Friendly Guide (2nd ed.). O'Reilly Media.
3. Lutz, M. (2013). Learning Python (5th ed.). O'Reilly Media.
4. Downey, A. B. (2015). Think Python: How to Think Like a Computer Scientist (2nd ed.). O'Reilly Media.
5. Beazley, D., & Jones, B. K. (2013). Python Cookbook: Recipes for Mastering Python 3 (3rd ed.). O'Reilly Media.

Paper 4: Mathematics for Data Science- II, Interdisciplinary

Course Objectives: The objectives of mathematics in data science are to provide the theoretical foundations and analytical tools necessary for extracting meaningful insights, making predictions, and solving real-world problems using data.

Course Outcomes (COs): After completion of the course, the students shall be able to:

Course Outcome (CO)	Description
CO1	Students will gain a comprehensive understanding of set theory, including the definition and types of sets, set operations such as union, intersection, and complements, as well as key theorems, laws, and the use of Venn diagrams in problem-solving
CO2	Students will develop the ability to apply the concepts of permutation and combination, understand different types of permutations, properties of permutations, and solve problems related to the difference between permutation and combination
CO3	Students will be able to compute the eigenvalues and eigenvectors of matrices, understand their significance in linear transformations, and apply these concepts to solve problems in matrix analysis, including quadratic forms
CO4	Students will demonstrate an understanding of Boolean algebra, fundamental theorems of Boolean operations, and the ability to construct and interpret truth tables to perform logical operations effectively
CO5	Students will be able to apply set theory and Boolean algebra in real-world problems, utilizing the principles of union, intersection, complement, and logical operations to solve complex problems in mathematics and computer science

CO6	Students will acquire analytical skills in matrix operations, including computing eigenvalues and eigenvectors, and understand how to apply these skills in both theoretical and practical applications, particularly in fields such as machine learning and physics

Course Content:

Unit No.	Unit Title	Topics Covered	Hours Allocated
1	Set Theory	Concept of Set Theory. Defining sets and Types of Sets. Symbols and Terminologies, Algebra of Set Theory- Union, Intersection, compliments Theorems and Laws, Operations on Set Theory, Relations, Venn Diagram	15
2	Eigen values and Eigen Vectors	Overview of Eigen values and Eigen vectors Computation of Eigen values and Eigen vectors of matrices Quadratic Forms of matrix. LU Factorization, Linear Transformation, Vectors Linear dependence and Independence Inner product	15
3	Boolean algebra	Overview, Fundamental Theorems of Boolean algebra, Truth Tables, Logical Basic Operations	10
Total	-	-	**40**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	1	1	1	1	2	1	2	2
CO2	2	1	2	1	1	1	2	1	2	2
CO3	3	1	3	3	1	2	3	1	2	2
CO4	2	2	2	2	1	1	2	2	2	2
CO5	3	2	3	2	3	2	3	2	3	3
CO6	3	2	3	3	1	3	3	1	2	3
AVERAGE	**2.5**	**1.5**	**2.33**	**2**	**1.33**	**1.67**	**2.5**	**1.33**	**2.2**	**2.33**

SUGGESTED READING:

1. "Linear Algebra and Its Applications" by Gilbert Strang.

2. "Discrete Mathematics" by Richard Johnsonbaugh

Paper 5: Marketing Analytics (CVA: Value Based)

Course Objective: The course aims at imparting knowledge on understanding and Familiarize with the fundamental to analyses market data and apply marketing analytics concepts to solve real world business problem and develop basic marketing model. This course equips with the knowledge and skills to utilize marketing data for informed decision-making and use statistical techniques like regression analysis and clustering to understand consumer behavior. Course analyses marketing data using tools like pivot table and excel charts to gain insight in to consumer behavior.

Course Outcomes (COs): After completion of the course, the students shall be able to:

Course Outcomes	Description
CO1: Introduction to Marketing Analytics	Understand the fundamental concepts of Marketing Analytics, including data-driven marketing approaches, marketing engineering, and model building, and apply pivot tables and Excel charts to analyse and summarize marketing data.
CO2:Pricing Analytics	Analyse different pricing strategies using pricing analytics techniques, including demand estimation, price optimization, price bundling, non-linear pricing, and price skimming, to make informed pricing decisions.
CO3:Marketing Forecasting	Apply regression techniques such as simple and multiple regression to forecast sales, and use time-series forecasting models like trend analysis, seasonality modelling, moving average methods, and Winter's Method to predict market trends.
CO4: Strategic Marketing Analytics	Implement the STP (Segmentation, Targeting, and Positioning) framework to generate customer value and manage the segmentation process effectively in marketing strategy development.
CO5: Cluster Analysis	Utilize clustering techniques, including hierarchical and non-hierarchical (K-Means) clustering, to perform customer segmentation and analyse market segments based on real-world data..
CO6: Discriminant Analysis	Apply discriminant analysis techniques to predict customer segment membership, enhancing decision-making in marketing strategy and customer targeting.

Course Content

Unit No.	Unit Title	Topics Covered	Hours Allocated

1	Introduction to Marketing Analytics	Study of discrete random variables, moments, and large deviations analysis.	1
2	Pricing Analytics	Analysis of multiple random variables, joint distributions, order statistics, and conditional expectations.	2
3	Marketing Forecasting	Study of bivariate normal distribution and its properties.	3
4	Strategic Marketing Analytics	Probability bounds, convergence types, law of large numbers, and central limit theorem applications.	4
5	Cluster Analysis	Understanding stochastic processes, Poisson processes, and Markov chains.	5
6	Discriminant Analysis	Bayesian statistics, prior/posterior distributions, and Bayesian estimation techniques	**6**
Total	-	-	**21**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	-	-	2	2	3	-	-	-
CO2	1	-	-	-	-	-	2	3	-	-
CO3	1	-	-	-	-	2	3	-	-	3
CO4	1	-	-	1	-		2	3	-	-
CO5	-	-	1	1	-	2	3	3	-	-
CO6	1	-	1	-	-	2	3	-	1	3
AVERAGE	**1.00**	**1.00**	**1.00**	**1.00**	**2.00**	**2.00**	**2.67**	**3.00**	**1.00**	**3.00**

Suggested Reading:

1. Marketing Analytics: A Practical Guide to Improving Consumer Insights Using Data Techniques" – Mike Grigsby
2. Marketing Analytics: Data-Driven Techniques with Microsoft Excel" – Wayne L. Winston.
3. Forecasting: Principles and Practice" – Rob J. Hyndman & George Athanasopoulos

LAB PAPER: Packages in python programming and Data processing

Course Objectives:

The objective of this course is to provide students with a comprehensive understanding of Python's core data analysis and machine learning libraries—**NumPy**, **Pandas**, **Matplotlib**, **SciPy**, and **Scikit-learn**. This course aims to equip learners with the foundational skills necessary for effective data manipulation, visualization, scientific computation, and machine learning model development.

1. Explain the differences between SQL and NoSQL databases.
2. Install, configure, and execute basic MongoDB commands.
3. Perform CRUD (Create, Read, Update, Delete) operations effectively.

Course Outcomes (COs) :

CO No.	Course Outcome (CO)
CO1	Understand and explain the concept of arrays, data types, and matrix operations using NumPy.
CO2	Demonstrate the ability to manipulate and analyze data using Pandas Series and DataFrames.
CO3	Create and interpret different types of plots (line, scatter, histogram, etc.) using Matplotlib.
CO4	Apply SciPy libraries to perform scientific and engineering computations, including optimization.
CO5	Use Scikit-learn to preprocess data, perform classification and clustering, and evaluate models.
CO6	Implement security measures, user authentication, performance tuning, and backup strategies.

COURSE CONTENT:

Unit No.	Unit Title	Topics Covered	Duration (Hours)
Unit I	**NumPy**	1.1 Array 1.2 Multi-Dimensional Array 1.3 Data Types 1.4 Random Number 1.5 Matrix Operations 1.6 Importance of NumPy array in statistical manipulation	5 Hours
Unit II	**Pandas**	2.1 Series, DataFrame 2.2 Importing CSV, Exporting CSV 2.3 Group By 2.4 Describe, Info 2.5 Iloc, Loc 2.6 Filtering	5Hours

Unit No.	Unit Title	Topics Covered	Duration (Hours)
		2.7 Slicing 2.8 Utilization of Pandas in Python Programming	
Unit III	**Matplotlib**	3.1 Line Plot 3.2 Scatter Plot 3.3 Histogram 3.4 Boxplot 3.5 Subplots 3.6 Pie Charts 3.7 Importance of Matplotlib in Visualization	6 Hours
Unit IV	**SciPy**	4.1 Introduction 4.2 SciPy Constant 4.3 Optimizer 4.4 Parse Data 4.5 SciPy Graphs	6 Hours
Unit V	**Scikit-Learn Library**	5.1 Dimensionality Reduction 5.2 Data Pre-processing 5.3 Model Selection 5.4 Classification 5.5 Clustering	8 Hours

Suggested Readings:

1. McKinney, W. (2022). *Python for data analysis: Data wrangling with pandas, NumPy, and Jupyter* (3rd ed.). O'Reilly Media.
2. Géron, A. (2022). *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems* (3rd ed.). O'Reilly Media.
3. VanderPlas, J. (2016). *Python data science handbook: Essential tools for working with data*. O'Reilly Media.
4. Tosi, S. (2009). *Matplotlib for Python developers*. Packt Publishing.
5. Rojas, S. J. G. (2015). *Learning SciPy for numerical and scientific computing* (2nd ed.). Packt Publishing

LAB PAPER: Open Elective - III: Data Processing and EDA in Microsoft Power BI

Course Outcomes (COs)

CO Number	Details
CO-1	Understand the Fundamentals of Business Intelligence and Power BI. Explain the concept of Business Intelligence (BI) and Self-Service BI. Compare Power BI with other BI tools like Tableau and QlikView. Describe the components, architecture, and benefits of Power BI.

CO-2	Perform Data Extraction, Transformation, and Loading (ETL) in Power BI. Identify and connect to various data sources using Power BI Desktop. Utilize the Power Query Editor for cleaning, transforming, and merging data. Manage data relationships and optimize data models for efficient analysis.
CO-3	Apply Data Analysis Expressions (DAX) for Data Manipulation. Understand DAX syntax, operators, and functions. Implement calculated tables, measures, and ranking functions in Power BI. Design schema relations and apply star schema principles for effective data modeling.
CO-4	Create and Customize Data Visualizations in Power BI. Develop interactive charts, tables, slicers, and maps for effective data representation. Customize visual elements like colors, shapes, text boxes, and images. Utilize Key Performance Indicator (KPI) visuals and time-based data exploration.
CO-5	Leverage Power BI Service for Collaboration and Insights. Differentiate between dashboards and reports in Power BI Service. Implement Quick Insights and Power BI Q&A for data-driven decision-making. Embed Power BI reports and create custom Q&A suggestions for enhanced interactivity.
CO-6	Develop End-to-End Power BI Solutions. Integrate multiple Power BI components to build comprehensive data analytics solutions.

COURSE CONTENT:

Session No.	Topic	Subtopics Covered	Duration (Hours)
Unit 1: Introduction to Power BI			
1	Business Intelligence and SSBI	Business Intelligence, Self-Service BI, SSBI Tools	1
2	Power BI Overview	Power BI vs Tableau vs QlikView, What is Power BI, Why Power BI?	1
3	Key Features and Architecture	Key Benefits, Flow, Components, Architecture, Building Blocks	2
Unit 2: Power BI Desktop and Data Transformation			
4	Power BI Desktop Overview	Data Sources, Connecting to Data, Query Editor	1

5	Data Transformation	Query Ribbon, Cleaning and Transforming Data, Merging & Appending Data	2
6	Data Modeling	Views in Power BI, Managing Data Relationships, Automatic Updates	2
7	Advanced Data Modeling	Cross Filter Direction, Calculated Tables & Measures, Optimizing Data Models	2
Unit 3: Data Analysis Expressions (DAX)			
8	Introduction to DAX	DAX Concepts, Importance, Syntax, Data Types	2
9	DAX Functions & Measures	Ranking, Filters, Context Interactions, Calculation Types	2
10	Advanced DAX	DAX Operators, Tables, Queries, Compound Measures, Schema Relations	2
Unit 4: Data Visualization			
11	Introduction to Visuals	Charts, Tables, Slicers, Map Visualizations	2
12	Advanced Visualizations	Gauges, Scatter, Waterfall, Funnel Charts, KPI Visuals	2
13	Customizing Visuals	Modifying Colors, Shapes, Text Boxes, Custom Visuals, Page Formatting	2
Unit 5: Power BI Service, Q&A, and Quick Insights			
14	Introduction to Power BI Service	Workspaces, Dashboards vs Reports, Quick Insights	1
15	Creating and Configuring Dashboards	Power BI Q&A, Natural Language Queries	1
16	Advanced Service Features	Power BI Embedded, Custom Q&A, Tile Details, Widgets	2
Unit 6: Connectivity Modes			
17	Excel and Live Connections	Using Excel Data, Live Data Connections	1
18	Direct Data	SQL Azure, HD Spark,	1

	Connections	SQL Server, MySQL	
19	Power BI API & Integration	Power BI API, Power View, Power Pivot, Data Refresh	2
Unit 7: Advanced Analytics in Power BI			
20	Parameters and Data Flow	Using Parameters, Creating Data Flow	1
21	Advanced Analytics Features	Anomaly Detection, Smart Narrative, Sensitivity Labels	2
22	Deployment Pipeline	Introduction to Deployment Pipeline	1
Practical Implementation & Case Studies			
23	Hands-on Data Modeling	Real-time case study on data transformation	1
24	Hands-on DAX Functions	Applying DAX functions in real datasets	1
25	Hands-on Data Visualization	Creating and customizing reports & dashboards	2
26	Power BI Service Implementation	Live project on report publishing and sharing	2
Final Project & Assessment			
27	Project Proposal & Data Collection	Defining project scope, dataset selection	1
28	Data Transformation & Modelling	Applying Power BI techniques to transform data	1
29	Visualization & Dashboard Creation	Building a comprehensive Power BI report	1
30	Presentation & Evaluation	Presenting the final project, feedback & assessment	1

SEMESTER-IV

Course Structure of B.Sc. (H) in Data Science							
B.Sc. SEMESTER IV							
Type	Subject Code	Subject (Theory)	L	T	P	Total Credit	Total Marks
DSC	TIU-UDS-MJ-T22201	Regression and Time Series	3	1	0	4	100
DSC	TIU-UDS-MJ-T22202	Introduction to Cloud Computing	3	0	0	3	100

DSC	TIU-UDS-MJ-T22203	Object Relational and NoSQL Databases	3	0	0	3	100
Interdisciplinary	TIU-UDS-MD-T2201	HR Metrics and Analytics	2	0	0	2	100
CVA	TIU-UDS-CVA-T2201	Operation Research and optimization techniques	2	0	0	2	100
Sessional	TIU-UDS-AEC-S2201	Object Relational and NoSQL Databases & Data visualisation including R programming (Practical)	0	0	2	2	100
OEC	TIU-UDS-MI-S22201A	Open Elective - IV: Data Visualization using Python Programming	0	0	2	2	100
SEC	TIU-UES-SEC-S2201	Entrepreneurship Skill Development	0	2	0	2	100
-	-	4th Semester Total	-	-	-	20	900

Paper 1: Regression and Time Series DSC: Discipline Specific Core (Course)

Course Objective:

To analyze and interpret complex datasets, make informed predictions, and derive actionable insights that drive decision-making in various fields such as finance, economics, marketing, and engineering.

Course Outcomes (COs): After completion of the course, the students shall be able to:

Course Outcomes	Description
CO1: Understand the Basics of Regression and Time Series Analysis. Identify and Analyse the Components of a Time Series:	Define regression and time series analysis. Differentiate between cross-sectional data and time series data. Decompose time series data into its fundamental components: trend, seasonal, cyclical, and irregular components. Utilize various methods to identify and measure these components.
CO2: Conduct Trend Analysis	Define and understand trend analysis in the context of time series data. Apply different techniques to estimate and model trends in time series data.
CO3: Perform De-seasonalisation	Understand the concept of seasonality in time series data. Apply methods to remove seasonal effects from time series data to better understand underlying trends.

CO4: Apply Exponential Smoothing Techniques	Explain the principles behind exponential smoothing. Implement simple exponential smoothing, Holt's linear trend method, and Holt-Winters seasonal method.
CO5: Develop and Assess Forecasting Models. Explore Advanced Time Series Models	Create and evaluate forecasting models for time series data. Understand the various risks and limitations associated with forecasting. Define and apply Auto Regressive (AR) models. Define and apply Moving Average (MA) models. Combine AR and MA models to form ARMA and ARIMA models.
CO6: ANOVA and its application	Understand the Principles of ANOVA .Differentiate Types of ANOVA .Interpret ANOVA Results

Course Contents:

Unit No.	Unit Title	Topics Covered	Hours Allocated
1	Linear Regression	A statistical method to model the relationship between a dependent variable and one or more independent variables using a linear equation.	10
2	Generalized Linear Model (GLM):	An extension of linear regression that allows for response variables to have different distributions (e.g., binomial, Poisson) by using a link function.	6
3	Model Building and Validation	The process of selecting, training, and fine-tuning a predictive model, followed by assessing its performance using techniques like cross-validation and error metrics.	4
4	Time Series Analysis	A method to analyze data points collected over time to identify patterns, trends, seasonality, and forecast future values.	16
5	Analysis of Variance (ANOVA)	A statistical technique used to compare the means of multiple groups to determine if there are significant	9

		differences between them.	
Total	-	-	45

CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0
CO1	1						2	1		
CO2	1				3	2	2	1		
CO3										
CO4	1	2	3		3					
CO5			2	2			2		3	
CO6			2			2		1		3
AVERAGE	1.0 0	2.00	2.33	2.00	3.00	2.00	2.00	1.00	3.00	3.00

Suggested Reading:

1. "Introduction to Linear Regression Analysis" – Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining

2. Applied Regression Analysis" – Norman R. Draper, Harry Smith.

3. The Elements of Statistical Learning" – Trevor Hastie, Robert Tibshirani, Jerome Friedman

Paper 2: Introduction to Cloud Computing DSC: Discipline Specific Core

Objective: The course objective for Cloud Computing typically aims to provide students with a comprehensive understanding of cloud technologies and their application in the modern IT landscape. Gain a clear understanding of the basic concepts of cloud computing, including its definition, key characteristics, service models (IaaS, PaaS, SaaS), and deployment models (public, private, hybrid, and community clouds).

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO Number	Details
CO-1	Understand the fundamentals of networking, including LAN, WAN, TCP/IP, IP addressing, and networking devices such as switches, hubs, routers, and firewalls.
CO-2	Analyze the architecture and components of client-server networking models and their role in web networking environments.

CO-3	Gain insights into different computing paradigms, including grid computing, utility computing, distributed computing, and cluster computing.
CO-4	Evaluate cloud computing concepts, including virtualization, emulation, computing models, and cloud service types (public, private, hybrid).
CO-5	Explore enterprise-level virtualization technologies, such as VMware, and assess their impact on business applications and IT infrastructure.
CO-6	Examine the NIST definition of cloud computing, including cloud deployment models, service models (IaaS, PaaS, SaaS), and security considerations.

Course Contents:

Unit No.	Unit Title	Topics Covered	Duration (Hours)
1	**Web Networking**	1.1 Networking basics	**12**
		1.2 LAN / WAN	
		1.3 Client / Server	
		1.4 TCP / IP	
		1.5 IP Addresses	
		1.6 Switches / Hubs / Routers	
		1.7 Firewalls	
2	**Overview of Cloud Computing**	2.1 Grid Computing	**22**
		2.2 Utility Computing	
		2.3 Distributed Computing	
		2.4 Cluster Computing	
		2.5 Cloud Computing	
		2.6 Virtualization basics	
		2.7 Benefits	
		2.8 Emulation	
		2.9 Virtualization for Enterprises	
		2.10 VMWare	
		2.11 Public/Private Internet	
		2.12 Routing/Switching to the Data Center	
		2.13 Bandwidth	
		2.14 Computing model, Comparison with other computing models, Pros and Cons of Cloud Computing	
3	**NIST Model**	3.1 NIST definition of Cloud Computing	**6**

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO-1	2	2	1	-	-	1	2	1	-	2
CO-2	2	3	1	1	-	2	3	1	-	2
CO-3	2	2	3	3	2	2	2	1	-	2
CO-4	2	3	2	3	2	2	2	1	1	3
CO-5	1	3	2	3	3	3	2	1	2	3
CO-6	2	3	3	3	2	3	3	1	2	3
AVERAGE	1.83	2.67	2.00	2.60	2.25	2.17	2.33	1.00	1.67	2.50

Suggested Readings for Cloud Computing

1. **"Cloud Computing: Principles and Paradigms"** – Rajkumar Buyya, James Broberg, and Andrzej Goscinski
2. **"Cloud Computing: Theory and Practice"** – Dan C. Marinescu
3. **"Mastering Cloud Computing: Foundations and Applications Programming"** – Rajkumar Buyya, Christian Vecchiola, and S. Thamarai Selvi
4. **"Cloud Computing Bible"** – Barrie Sosinsky
5. **"Cloud Computing: Concepts, Technology & Architecture"** – Thomas Erl, Ricardo Puttini, Zaigham Mahmood

Paper 3: Object Relational and NoSQL Databases DSC: Discipline Specific Core (Course)

Course Objective:

The course objective for "Object Relational and NoSQL Databases" aims to equip students with a comprehensive understanding of both object-relational and NoSQL database technologies, their design principles, and practical applications and the thorough understanding of object-relational and NoSQL databases, design, implementation that manage database solutions that meet the needs of modern applications.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO Number	Details
CO-1	Understand the fundamentals of Object-Relational Databases (ORDBMS), their structure, and how they address the limitations of traditional Relational Database Management Systems (RDBMS).
CO-2	Compare and contrast Object-Oriented Database Management Systems (OODBMS) and ORDBMS, analyzing their advantages, storage mechanisms, and indexing strategies.

CO-3	Explore Object-Relational Queries and their usage in modern database applications, including indexing and optimization techniques.
CO-4	Analyze the need for NoSQL databases, their advantages over traditional RDBMS, and their classification into document-oriented, column-oriented, key-value stores, and graph databases.
CO-5	Evaluate different NoSQL database technologies, including MongoDB, Apache Cassandra, Riak, and Neo4j, and their applications in handling large-scale data.
CO-6	Develop a practical database project by integrating ORDBMS and NoSQL database concepts to design, implement, and optimize a data storage solution for real-world applications.

Course Contents

Unit No.	Unit Title	Topics Covered	Duration (Hours)
1	**Object-Relational Database**	1.1 Introduction and Overview of Object-Relational Database	**12**
		1.2 Problems with RDBMS	
		1.3 OODBMS	
		1.4 ORDBMS	
		1.5 Storage	
		1.6 Object relational queries	
		1.7 Indexing	
		1.8 Usage	
2	**Introduction to NoSQL Databases**	2.1 Storage in a conventional RDBMS, its problems, and their solution with non-conventional systems	**10**
		2.2 Familiarization with the four types - Document-oriented, Column-oriented, Key-value pairs, and Graph	
		2.3 A bit of historical context	
3	**Some NoSQL Database Examples**	3.1 MongoDB	**10**
		3.2 Apache Cassandra	
		3.3 Riak	
		3.4 Neo4j	
4	**Group Project**	Practical implementation of ORDBMS and NoSQL concepts in a real-world scenario	**8**

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO-1:	**3**	**1**	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**2**
CO-2:	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**
CO-3:	**2**	**3**	**2**	**1**	**2**	**3**	**3**	**2**	**2**	**3**
CO-4:	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**3**
CO-5:	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**
CO-6:	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**
AVERAGE	2.33	2.50	2.50	2.00	2.33	2.67	2.83	2.00	2.00	2.83

Suggested Readings for Object-Relational & NoSQL Databases

1. **"NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence"** – Pramod J. Sadalage and Martin Fowler
2. **"Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement"** – Eric Redmond and Jim R. Wilson
3. **"SQL and NoSQL Databases: Models, Languages, Consistency Options and Architectures for Big Data Management"** – Thomas M. Connolly and Carolyn E. Begg
4. **"Object-Oriented Database Systems: Approaches and Architectures"** – R. Elmasri and S.B. Navathe
5. **"MongoDB: The Definitive Guide"** – Shannon Bradshaw, Eoin Brazil, and Kristina Chodorow
6. **"Cassandra: The Definitive Guide"** – Jeff Carpenter and Eben Hewitt
7. **"Graph Databases"** – Ian Robinson, Jim Webber, and Emil Eifrem

Paper 4: HR Metric and Analytics Interdisciplinary

Course Objective:

1. Understand the role of HR Metrics in business performance evaluation.
2. Analyse HR data to correlate HR functions with business success.
3. Differentiate between HR process metrics, HR outcome metrics, and KPIs.
4. Identify key roles in HR Analytics projects and their impact on data-driven decision-making.
5. Apply the HR Analytics Value Pyramid to transition from basic reporting to business intelligence.
6. Effectively communicate HR insights to stakeholders for strategic HR decision-making.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO Number	Details
CO1	Categorize HR data into process and outcome metrics and explain their impact on

	business performance.
CO2	Analyze HR metrics to connect HR activities with overall business outcomes.
CO3	Differentiate between HR process metrics, HR outcome metrics, and KPIs to measure HR effectiveness.
CO4	Identify key roles in HR analytics projects and their contributions to data-driven decision-making.
CO5	Apply the HR Analytics Value Pyramid to move from basic HR reporting to business optimization.
CO6	Communicate HR analytics insights effectively to key stakeholders.

COURSE CONTENT:

Unit	Unit Title	Topics Covered	Duration (Hours)
Unit 1	Introduction to HR Analytics	HR data categories, Relating HR measures to business outcomes, HR process metrics vs. outcome metrics	5
Unit 2	HR Metrics and Business Outcomes	Examples of HR metrics, Difference between metrics & KPIs, Linking HR metrics to business strategy	6
Unit 3	HR Analytics Project Roles	Roles in People Analytics projects, HR analyst, Data analyst, Business Partner involvement	5
Unit 4	HR Analytics Value Pyramid	The 4-step HR Value Pyramid, Transitioning from HR reporting to optimization	6
Unit 5	Advanced HR Metrics and Reporting	HR Dashboards, Predictive HR Analytics, Workforce Forecasting	5
Unit 6	Case Studies & Applications	Real-world HR Analytics Case Studies, Practical Data Interpretation	5
Unit 1	Introduction to HR Analytics	HR data categories, Relating HR measures to business outcomes, HR process metrics vs. outcome metrics	5

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	1	1	2	2	2	3	2	3
CO2	3	1	1	1	2	2	2	3	3	3
CO3	3	1	1	1	2	2	3	3	2	3
CO4	3	2	2	1	2	3	3	3	2	3
CO5	3	1	1	1	2	2	2	3	3	3
CO6	3	1	1	1	2	3	3	3	2	3
Average	3	1	1	1	2	2	3	3	2	3

Suggested Readings

1. Understand the role of HR Metrics in business performance evaluation.
2. Analyse HR data to correlate HR functions with business success.
3. Differentiate between HR process metrics, HR outcome metrics, and KPIs.

4. Identify key roles in HR Analytics projects and their impact on data-driven decision-making.
5. Apply the HR Analytics Value Pyramid to transition from basic reporting to business intelligence.
6. Effectively communicate HR insights to stakeholders for strategic HR decision-making.

Paper 5: Operation Research and Optimization Techniques Core Value Based Course

Course Objective: The course aims at imparting knowledge on business decision making in the tactical, operational, and strategic arenas to apply constrained optimization techniques through quantitative data analysis.

Course Outcomes (COs): After completion of the course, the students shall be able to:

Course Outcome (CO)	Description
CO1	Students will be able to define Operations Research, its origin, and nature, and evaluate its impact on decision-making processes across various industries. They will also demonstrate the ability to apply the OR modelling approach, including problem definition, data collection, mathematical model formulation, solution, testing, and implementation
CO2	Students will gain the ability to solve optimization problems by understanding key concepts like optimality, maximization/minimization, and constraints. They will be proficient in applying unconstrained and constrained optimization techniques, including the use of Taylor's Theorem, gradient descent, and Newton's method, to find optimal solutions
CO3	Students will be able to formulate and solve Linear Programming Problems (LPP) using the simplex method, and perform post-optimality analysis such as re-optimization, shadow pricing, and sensitivity analysis. They will also understand the economic interpretation of duality and the primal-dual relationship in linear programming
CO4	Students will be able to solve specialized problems such as transportation and assignment problems using simplex methods, and apply project management tools like PERT/CPM to manage time and resources efficiently in a project
CO5	Students will learn to formulate and solve non-linear programming problems, both with and without constraints. They will be able to apply the Kuhn-Tucker conditions for constrained optimization and use quadratic and convex programming techniques to solve complex non-linear optimization issues
CO6	Students will be able to model and optimize inventory systems using techniques like EOQ, stochastic continuous review, and multi-echelon inventory models. Additionally, they will be skilled in using Monte Carlo simulations to model uncertainty, reduce variance, and make decisions based on pseudo-random number generation, understanding how to design simulations for estimating quantities of interest.

Course Content:

Unit No.	Unit Title	Topics Covered	Hours Allocated
1	Introduction to Operations Research	Introduction: Origin of OR, Nature of OR work, Impact of OR works. Overview of OR modelling approach: Problem definition, Gathering of Data, Mathematical model formulation, Solution to the problem, testing of model, Implementation of model	5
2	Optimization Techniques	Concept of Optimality and Optimization: Maximization/Minimization problem, equality/inequality constraints. Some Geometry and Matrix Properties for Optimization. Unconstrained optimization – Mean Value and Taylor's Theorem, Necessary and Sufficient condition for optimality. Convex and Concave functions and Convex sets, Concave function and differentiability. Gradient descent and line search method, approximate line search and convergence of gradient descent. Convergence issues and Newton's method of correction.	5
3	Linear Programming and Simplex method	Prototype example: Formulation of LPP and graphical solution. LP model: Standard form, other forms, notations, and terminologies. Assumptions of LPP: Proportionality, Additivity, Divisibility and Certainty Solving LPP using simplex method: The concept, algebra of simplex method, solution. Adapting Simplex method to other forms of model. Post Optimality Analysis: re-optimization, Shadow price, sensitivity analyses. Dual Theory, economic interpretation of duality, Concept of primal dual relationship, applying sensitivity analysis	5
4	Specific problems	The Transportation and Assignment Problems: Problem definition, Simplex method of solution, Assignment problem. Project Management with PERT/CPM	5
5	Non-Linear Programming	Types of non-linear programming. One variable unconstrained optimization, multivariable unconstrained optimization. Kuhn-Tucker condition for constrained optimization. Quadratic programming Convex programming	5
6	Game Theory	Two-person zero sum game. Payoff matrix. Minimax and Maximin solution. Randomized strategies, Graphical solution	5
7	Inventory Theory	Components of inventory models – Continuous review model - Basic EOQ models with planned	5

		shortages and quantity discounts. Observations about EOQ models. Stochastic Continuous review model – Choosing and order quantity, choosing a reorder point. Multiple Inventory systems, Multiechelon Inventory systems. Supply chain management	
8	Simulation	Concept of variance reduction: Monte Carlo" simulation using a series of pseudo-random numbers Explain the disadvantages of using truly random, as opposed to pseudo-random numbers. Describe how pseudo-random drawings from specified distributions can be generated. Explain the circumstances in which the same set of random numbers would be used for two sets of simulations and the circumstances in which different sets would be used. Discuss how to decide how many simulations to carry out in order to estimate a quantity of interest	5
Total	-	-	**40**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	2	1	1	1	2	2	2	1
CO2	3	2	3	1	2	2	3	2	2	2
CO3	3	2	3	2	2	2	3	3	2	2
CO4	3	2	3	1	2	2	3	2	2	1
CO5	3	2	3	1	2	3	3	2	2	1
CO6	2	3	3	3	3	3	3	3	2	2
AVERAGE	2.66	2	2.83	1.5	2	2.16	2.83	2.33	2	1.5

SUGGESTED READING:

1. "Operations Research: An Introduction" by Taha, H.
2. "Operations Research" by S. D. Sharma.
3. "Operations Research: Methods and Applications" by J. K. Sharma.

LAB PAPER: Open elective IV, Data Visualization using Python Programming

Course Objective:

1. To provide an understanding of Exploratory Data Analysis (EDA) and the principles of analytic graphics.
2. To introduce Python plotting libraries, such as Matplotlib, Seaborn, and ggplot, for effective data visualization.
3. To equip students with advanced graphing techniques using lattice plotting and color schemes.

4. To develop skills in interactive visualization using Bokeh to enhance user engagement.
5. To enable students to choose the appropriate data visualization technique for different types of datasets.
6. To explore additional visualization tools and packages that support complex data representation.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO Number	Details
CO1	Understand and apply the principles of exploratory data analysis (EDA) to visualize and interpret datasets effectively.
CO2	Utilize various plotting systems, including base plotting, lattice plotting, and color schemes, for advanced graphing techniques.
CO3	Implement data visualization using Python libraries such as Matplotlib, ggplot, and Seaborn to generate meaningful insights.
CO4	Develop interactive data visualizations using Bokeh to enhance user engagement and interactivity in data exploration.
CO5	Explore and apply additional visualization tools and packages to support complex data representation and storytelling.
CO6	Demonstrate the ability to choose and implement appropriate visualization techniques for different types of datasets and analytical tasks.

COURSE CONTENT:

Module No.	Exp. No.	Experiment Name	Course Outcome (CO)
Module 1	1	Perform basic exploratory data analysis using a sample dataset (mean, median, std, etc.).	CO1
	2	Create simple exploratory graphs using Python's base plotting system.	CO1
	3	Demonstrate principles of good graphical representation using simple charts.	CO1
Module 2	4	Create lattice plots to visualize multi-variable data.	CO2
	5	Apply different color schemes and palettes in visualizations.	CO2
Module 3	6	Create a line chart, bar chart, and histogram using Matplotlib.	CO3

	7	Customize Matplotlib charts with labels, legends, titles, and styles.	CO3
	8	Visualize grouped data using Seaborn’s barplot, boxplot, and violinplot.	CO3
	9	Create layered plots using ggplot in Python.	CO3
	10	Compare visualizations using Matplotlib vs Seaborn for the same dataset.	CO3
Module 4	11	Build an interactive line chart using Bokeh.	CO4
	12	Create interactive bar charts and hover tooltips with Bokeh.	CO4
	13	Develop a dashboard-style layout using Bokeh for multiple plots.	CO4
Module 5	14	Create a tree map to represent hierarchical data.	CO5
	15	Visualize relationships using network graphs in Python.	CO5
	16	Generate 3D surface and scatter plots using Matplotlib's mplot3d.	CO5
Module 6	17	Case Study 1: Visualize business performance data using Python tools.	CO6
	18	Case Study 2: Create a scientific research visualization dashboard.	CO6
	19	Perform a full EDA and visualization workflow on a public dataset (e.g., Titanic, Iris, etc.).	CO6
	20	Final project presentation – students demonstrate visualization project integrating all tools.	CO6

Suggested Readings

1. Matthes, E. (2021). *Python Crash Course: A Hands-On, Project-Based Introduction to Programming (3rd ed.).* No Starch Press.
2. VanderPlas, J. (2016). *Python Data Science Handbook: Essential Tools for Working with Data.* O'Reilly Media.
3. McKinney, W. (2017). *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython (2nd ed.).* O'Reilly Media.
4. Hunter, J. D., Firing, E., Droettboom, M., & the Matplotlib Development Team. (2019). *Matplotlib: Visualization with Python.* Matplotlib Community.

5. Waskom, M. (2021). *Seaborn: Statistical Data Visualization.* O'Reilly Media.

LAB PAPER: Object Relational and NoSQL Databases & Data visualisation including R programming (Practical)

Course Objectives

This course aims to provide a deep understanding of **MongoDB**, a NoSQL database, covering essential concepts, data modeling, querying, replication, sharding, security, and performance tuning. The primary objectives of the course are: **Understand NoSQL and MongoDB Fundamentals.**

1. Explain the differences between SQL and NoSQL databases.
2. Install, configure, and execute basic MongoDB commands.
3. Perform CRUD (Create, Read, Update, Delete) operations effectively.

Course Outcomes (COs):

CO No.	Course Outcome (CO)
CO1	Explain the differences between SQL and NoSQL databases and install MongoDB.
CO2	Demonstrate CRUD operations, schema design, and data modelling techniques.
CO3	Implement indexing strategies and optimize query performance using MongoDB.
CO4	Apply querying techniques, aggregation framework, and MapReduce for data retrieval.
CO5	Configure replication (Replica Sets) and sharing for scalability and high availability.
CO6	Implement security measures, user authentication, performance tuning, and backup strategies.

Course Content:

Unit No.	Unit Title	Topics Covered	Duration (Hours)
1	Introduction to MongoDB	NoSQL vs SQL, MongoDB Installation, Basic Commands, CRUD Operations	6
2	Data Modeling and Indexing	Schema Design, Embedded vs Referenced Documents,	6

		Indexing Strategies	
3	Querying and Aggregation	Query Operators, Aggregation Framework, Pipeline Stages, MapReduce	6
4	Replication and Sharding	Replica Sets, Sharding Strategies, Load Balancing, High Availability	6
5	MongoDB Security and Performance Tuning	User Roles & Authentication, Performance Optimization, Backup & Recovery	6

Suggested Readings:

 "MongoDB: The Definitive Guide" *– by Shannon Bradshaw, Eoin Brazil, and Kristina Chodorow*

- A comprehensive guide covering MongoDB fundamentals, advanced topics, and real-world applications.

 "MongoDB in Action" *– by Kyle Banker*

- Explains MongoDB concepts with practical use cases and hands-on examples.

 "Mastering MongoDB" *– by Alex Giamas*

- Covers advanced topics such as replication, sharding, and performance tuning.

 "MongoDB Basics" *– by Peter Membrey, David Hows, and Eelco Plugge*

SEMESTER-V

B.Sc. SEMESTER V							
Course Structure of B.Sc.(H) in Data Science							
B.Sc. SEMESTER V							
Type	**Subject Code**	**Subject (Theory)**	**L**	**T**	**P**	**Total Credit**	**Total Marks**
DSC	**TIU-UDS-MJ-T31301**	**Business Analysis**	**3**	**0**	**0**	**3**	**100**
DSC	**TIU-UDS-MJ-T31302**	**Data Mining and Visualization Using R Programming**	**3**	**0**	**0**	**3**	**100**
DSC	**TIU-UDS-MJ-T31303**	**Introduction to Artificial Intelligence**	**4**	**0**	**0**	**4**	**100**
Interdisciplinary	**TIU-UDS-MD-S3101**	**Handling Human value in workplace**	**0**	**0**	**2**	**2**	**100**

OEC	**TIU-UDS-MI-S31201A**	**Open Elective - V: Leadership and Skill development at Workplace**	**0**	**0**	**4**	**4**	**100**
Internship	**TIU-UDS-MI-I31201**	**Internship, Project Work & Viva Voce**	**0**	**0**	**4**	**4**	**100**
		5th Semester Total				**20**	**700**

Paper 1: Business Analysis DSC: Discipline Specific Core (Course)

Course Objective:

1. Understand the fundamentals of Business Analysis and its role in enhancing business performance and decision-making.
2. Develop Business Analysis Planning and Strategy through effective stakeholder engagement, key performance indicator (KPI) identification, and process improvement techniques.
3. Apply Elicitation and Collaboration Techniques to gather, analyze, and document business requirements.
4. Conduct Strategy and Risk Analysis by evaluating current and future business states and mitigating risks.
5. Perform Requirement Analysis and Design Definition to specify, model, and validate business requirements effectively.
6. Implement Business Analysis Techniques and Forecasting for better decision-making using methods like Balanced Scorecard, Data Flow Diagrams, and Predictive Analytics.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO Number	Details
CO1	Understand Business Analysis Fundamentals
CO2	Develop Business Analysis Planning and Strategy
CO3	Apply Elicitation and Collaboration Techniques
CO4	Conduct Strategy and Risk Analysis
CO5	Perform Requirement Analysis and Design Definition
CO6	Implement Business Analysis Techniques and Forecasting

COURSE CONTENT:

Unit	Unit Title	Topics Covered	Duration (Hours)
Unit 1	Introduction to Business Analysis	1.1 What is business analysis 1.2 Business Analysis core concept 1.3 Key Terms 1.4 Requirement Classification 1.5 Requirements and design 1.6 Primary and secondary data	6

Unit 2	Business Analysis Planning	2.1 Plan business analysis approach 2.2 Understanding and planning stakeholder engagement 2.3 Defining Key-performance indicators 2.4 Plan business analysis information management 2.5 Identify business analysis performance improvement	8
Unit 3	Elicitation and Collaboration	3.1 Prepare elicitation 3.2 Conduct elicitation 3.3 Confirm elicitation results	6
Unit 4	Strategy and Risk Analysis	4.1 Analyze current state 4.2 Define future state 4.3 Assess risks	7
Unit 5	Requirement Analysis and Design Definition	5.1 Specify & Model requirements 5.2 Verify requirements 5.3 Validate requirements 5.4 Define requirement design architecture	8
Unit 6	Business Analysis Techniques	6.1 Acceptance and evaluation criteria 6.2 Balance Scorecard 6.3 Benchmarking 6.4 Business rule analysis 6.5 Data Flow diagram	9
Unit 7	Business Forecasting	7.1 Business forecasting 7.2 Business Intelligence 7.3 Benchmarking 7.4 Business rule analysis 7.5 Data Flow diagram	8

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	1	1	2	2	2	3	2	3
CO2	3	1	1	1	2	2	2	3	3	3
CO3	3	1	1	1	2	2	3	3	2	3
CO4	3	2	2	1	2	3	3	3	2	3
CO5	3	1	1	1	2	2	2	3	3	3
CO6	3	1	1	1	2	3	3	3	2	3
Average	3	1	1	1	2	2	3	3	2	3

Suggested Readings

1. International Institute of Business Analysis. (2015). A Guide to the Business Analysis Body of Knowledge (BABOK Guide) (Version 3.0). International Institute of Business Analysis.
2. Paul, D., Cadle, J., & Yeates, D. (2014). Business Analysis (3rd ed.). BCS, The Chartered Institute for IT.

3. Cadle, J., Paul, D., & Turner, P. (2010). Business Analysis Techniques: 72 Essential Tools for Success. BCS, The Chartered Institute for IT.
4. Palepu, K. G., & Healy, P. M. (2012). Business Analysis and Valuation: Using Financial Statements (5th ed.). Cengage Learning.
5. Bodily, S. E., Carraway, R. L., Frey, S. C., & Pfeifer, P. E. (1998). Quantitative Business Analysis: Text and Cases. Irwin/McGraw-Hill.

Paper 2: Data Mining and Visualization Using R Programming DSC: Discipline Specific Core (Course)

Course Objective:

Enable the student to understand fundamental concepts and principles of artificial intelligence and equip with the skills to design and develop intelligent systems .Students can prepare for careers in AI and related fields.

CO Number	Course Outcome Description
CO1	Explain fundamental R programming concepts, including data structures, operators, functions, control structures, and loops.
CO2	Perform data manipulation tasks using functions like Rbind, Cbind, handling missing values, and formatting datasets for analysis.
CO3	Apply data visualization techniques using ggplot, qplot, histograms, and density plots to analyze and represent data graphically.
CO4	Develop regression models (linear and logistic) in R to analyze relationships between variables and make predictions.
CO5	Implement and evaluate machine learning models, including classification techniques, confusion matrices, and accuracy measures.
CO6	Integrate R programming techniques for real-world applications in data analysis, visualization, and predictive modeling.

COURSE CONTENT:

Unit No.	Topic	Subtopics	Hours Allocated
Unit 1	**Introduction to R Programming**		**12 Hours**
	Index vector in R	Understanding and working with index vectors	2
	Data frame in R	Creating and manipulating data frames	2

	Data types in R	Different data types and their usage	1
	Operators expression in R	Arithmetic, logical, and relational operators	1
	Functions in R	Writing and using functions	2
	Control Structure in R	Conditional statements and control flow	1
	Looping and Branching in R	for, while, and repeat loops; if-else branching	2
Unit 2	**Data Manipulation in R**		**10 Hours**
	Rbind and Cbind functions in R	Combining datasets using Rbind and Cbind	1
	Working with different dataset and files	Reading and writing CSV, Excel, and text files	2
	Working with missing values in R	Identifying and handling missing values	2
	Filtering and formatting Data in R	Data selection and transformation techniques	2
	Linear Regression model in R	Implementing linear regression	2
	Logistic Regression model in R	Implementing logistic regression	1
Unit 3	**Data Visualization in R**		**10 Hours**
	ggPlot package in R	Overview of ggplot2 package	1
	Visualizing Data	Scatter plots, bar charts, line charts	2
	Using qplot	Quick plotting with qplot	2
	geom_histogram()	Creating histograms	1
	Geomdensity()	Density plots for distributions	1
	Scale fill_ Functions	Customizing plot colors and scales	1
	Figures with Multiple Plots	Arranging multiple plots in a figure	2
Unit 4	**Various Machine Learning models in R**		**13 Hours**
	Logistic regression and linear regression model	Implementing and comparing models	2
	Confusion Matrix	Evaluating model performance	2
	Classification models in R Programming	Decision trees, random forests, SVM	3
	Accuracy, sensitivity, and specificity	Evaluating classification models	2

	Model matrix and formula	Understanding the model matrix approach	2
	Cross Validation in R	Implementing cross-validation techniques	2
Total			**45 Hours**

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**1**	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
CO2	**-**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**
CO3	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**2**	**-**	**-**
CO4	**3**	**-**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**
CO5	**-**	**-**	**3**	**2**	**-**	**-**	**3**	**-**	**-**	**-**
CO6	**-**	**3**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**
AVERAGE	**2**	**3**	**2.333333**	**2**	**2.5**	**2**	**2.5**	**2**	**0**	**3**

SUGGESTED READING:

- **"Data Mining with R: Learning with Case Studies"** – Luis Torgo
- **"R for Data Science"** – Hadley Wickham & Garrett Grolemund (Free online)
- **"Data Mining: Practical Machine Learning Tools and Techniques"** – Ian H. Witten, Eibe Frank, Mark A. Hall
- **"The Elements of Statistical Learning"** – Trevor Hastie, Robert Tibshirani, Jerome Friedman (Good for advanced learners)
- **"ggplot2: Elegant Graphics for Data Analysis"** – Hadley Wickham

Paper 3: Introduction to Artificial Intelligence DSC: Discipline Specific Core (Course)

Course Objective:

The Introduction to Artificial Intelligence (AI) course aims to provide students with a strong foundation in AI concepts, techniques, and applications.

CO No.	Course Outcome
CO1	Demonstrate an understanding of AI fundamentals, including its history, principles, and subfields like ML, DL, and NLP.
CO2	Apply AI-based problem-solving techniques using search algorithms such as BFS, DFS, and A* Algorithm.
CO3	Implement knowledge representation and reasoning techniques using Propositional and First-Order Logic.

CO4	Develop and apply Machine Learning models, including classification, regression, clustering, and decision trees for real-world applications.
CO5	Analyze AI applications in robotics, automation, and expert systems, including NLP and Computer Vision techniques.
CO6	Evaluate ethical, societal, and regulatory implications of AI while implementing AI-based applications using Python, TensorFlow, and Scikit-learn.

COURSE STRUCTURE:

Unit No.	Topic	Subtopics	Hours Allocated
Unit 1	**Introduction to AI**		**10 Hours**
	What is AI?	Definition, scope, and applications of AI	2
	History of AI	Evolution of AI, key milestones	2
	Different stalwarts' contributions	Contributions of Turing, McCarthy, Minsky, and others	2
	Supervised and Unsupervised learning techniques	Differences, applications, examples	4
Unit 2	**Clustering - What, Why and How**		**14 Hours**
	Hard & Soft Clustering	Introduction to clustering techniques	2
	Different types of clustering models	Connectivity Models, Centroid Models, Density Models	3
	Different techniques	Nearest neighborhood, K-means, Fuzzy C-Means, Hierarchical clustering	5
	Applications of clustering	Real-world applications and case studies	4
Unit 3	**Propositional and Predicate Logic**		**8 Hours**
	Propositional logic	Logical statements, truth tables, logical operators	4
	Predicate logic	First-order logic, quantifiers, inference techniques	4
Unit 4	**Soft Computing**		**18 Hours**
	Fuzzy Sets	Introduction to fuzzy logic and fuzzy sets	3

	Neural Networks	Basics of perceptron, feedforward networks	4
	Rule Base & Decision Trees	Expert systems, decision tree algorithms	3
	Genetic Algorithms	Evolutionary computation, crossover, mutation	3
	Image Processing	Fundamentals and AI applications in image processing	3
	Pattern Recognition	Machine learning techniques for pattern recognition	2
Unit 5	**AI Ethics**		**10 Hours**
	Ethics in AI	Ethical considerations, biases in AI, AI and society	6
	Robotic Process Automation	Automation techniques, use cases, future trends	4
Total			**60 Hours**
	Logistic regression and linear regression model	Implementing and comparing models	2
	Confusion Matrix	Evaluating model performance	2
	Classification models in R Programming	Decision trees, random forests, SVM	3
	Accuracy, sensitivity, and specificity	Evaluating classification models	2
	Model matrix and formula	Understanding the model matrix approach	2
	Cross Validation in R	Implementing cross-validation techniques	2
Total			**45 Hours**

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**-**	**2**	**-**	**3**	**-**	**-**	**2**	**-**	**-**	**-**
CO3	**-**	**-**	**-**	**3**	**-**	**-**	**2**	**-**	**-**	**-**
CO4	**1**	**2**	**3**	**3**	**-**	**2**	**3**	**-**	**-**	**-**
CO5	**-**	**-**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**2**
CO6	**-**	**3**	**-**	**2**	**-**	**-**	**-**	**2**	**3**	**3**
AVERAGE	**1.5**	**2.33**	**2.33**	**2.83**	**2**	**2**	**2.33**	**2**	**0**	**2**

SUGGESTED READING:

 "Artificial Intelligence: A Modern Approach" – Stuart Russell & Peter Norvig (Widely used textbook for AI)

 "Machine Learning" – Tom M. Mitchell (Great for understanding ML concepts in AI)

 "Deep Learning" – Ian Goodfellow, Yoshua Bengio, & Aaron Courville (Focused on neural networks and deep learning)

 "Pattern Recognition and Machine Learning" – Christopher M. Bishop (For statistical AI and ML concepts)

 "AI: A Very Short Introduction" – Margaret A. Boden (A concise introduction to AI)

LAB PAPER: Handling Human value in workplace

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO1: Mastering Human Resource Development (HRD) Practices.

CO2: Understanding the Foundations of Human Resource Management (HRM).

CO3: Analysing Organisational Behaviour and Its Impact on Management.

CO4: Understanding Industrial Relations and Labour Law Practices

CO5: Navigating Industrial Disputes and Labour Welfare Practices.

CO6: Evaluating HR Policies and Practices in the Modern Business Environment.

COURSE CONTENT:

Unit – I Human Resource Management: Conceptual framework, Human Resource Planning, Job Analysis, Recruitment, Selection, Placement, Induction, Training and Development, Performance Management, Job Evaluation, Compensation Management, Employee Benefits and Incentives,

Unit - II Human Resource Development (HRD): Concepts, Assumptions, Values, HRD Mechanisms, Action – research Model, HRD Culture and Climate, HRD Interventions, HR Accounting and Audit, Consultant – client relationship, Knowledge Management, Human Resource Information systems.

Unit - III Organisational Behaviour: Concept, Scope, Nature of human behaviour, Personality, Perception, Learning, Attitude, Motivation, Interpersonal Behaviour, Group Dynamics, Leadership, Communication, Power and Authority, Stress, Organisational Change and Development.

Unit - IV Industrial Relations: Concept, Scope, Evolution, Approaches, Actors and Models, Conflict and cooperation, Bi-patriotism, Tri-patriotism, Collective Bargaining, Workers' Participation in Management, Grievance Handling and Disciplinary Action, Code of Conduct, Industrial Relations in changing scenario, Employers' organisations.

Trade Unions: Concepts, Evolution, Problems of trade unions in India, Recognition, The Trade Unions Act, 1926. Emerging role of trade unions in India.

Unit - V Industrial Disputes: Factors, Forms, Trends, Prevention and Settlement, Role of State and Central Labour Administration, Strikes and Lockouts. The Industrial Employment (Standing Orders) Act, 1946. The Industrial Disputes Act, 1947.

Unit - VI Labour Welfare: Concept, Scope, Types, Theories and Principles, Industrial Health and Hygiene, Industrial Accidents and safety, Occupational Diseases Social Security: Concept and Scope, Social Assistance and Social assurance.

BLOOM'S TAXONOMY:

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	2	2	2	2	1	2	2	2
CO2	2	3	2	3	3	2	2	3	3	2
CO	2	3	3	3	2	2	2	3	2	2
CO4	2	3	3	3	2	2	3	3	3	3
CO5	2	3	3	3	3	2	2	3	2	2
CO6	3	3	2	2	3	2	2	3	2	3
AVERAGE	**2.17**	**2.67**	**2.50**	**2.67**	**2.50**	**2.00**	**2.00**	**2.83**	**2.33**	**2.33**

SUGGESTED READING:

- "Human Resource Management" by Gary Dessler.

-"The New HR Leader's First 100 Days" by Alan Collins.

- "The Five Dysfunctions of a Team" by Patrick Lencioni

LAB PAPER: Open Elective - V: Leadership and Skill development at Workplace

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO No.	Course Outcome
CO1	Understand leadership principles and workplace skills.
CO2	Apply decision-making and problem-solving techniques.
CO3	Develop communication and teamwork strategies.
CO4	Implement time management and productivity tools.
CO5	Apply conflict resolution and negotiation strategies.
CO6	Evaluate ethical leadership and workplace professionalism.

COURSE STRUCTURE:

Unit No.	Topics Covered	Sessions (Hours)
Unit 1	**Introduction to Leadership & Workplace Skills**	**1-6 (6 hours)**
	Leadership: Definition, Importance, and Theories (Transformational, Servant, Situational)	01-Feb
	Hard vs. Soft Skills for Data Science Professionals	3
	Leadership Challenges in the Data Science Industry	4
	Self-Assessment: Identifying Leadership Styles	5
	Workplace Skills for a Data-Driven World	6
Unit 2	**Critical Thinking & Decision Making**	**7-12 (6 hours)**
	Problem-Solving Frameworks for Data-Driven Teams	7
	Decision-Making Techniques: Analytical vs. Intuitive Thinking	8
	Data-Driven Decision Making: Role of AI & ML	9
	Handling Uncertainty & Risk in Workplace Decisions	10
	Real-World Case Study on Decision Making	11
	Ethical Decision-Making in Leadership	12
Unit 3	**Communication & Teamwork**	**13-18 (6 hours)**
	Verbal & Non-Verbal Communication in the Workplace	13
	Effective Presentation Skills for Data Scientists	14
	Building Strong Team Collaboration	15

	Active Listening & Emotional Intelligence	16
	Leadership in Remote & Hybrid Work Environments	17
	Cross-Cultural Communication in Global Data Teams	18
Unit 4	**Time Management & Productivity**	**19-24 (6 hours)**
	Time Management Techniques: Pomodoro, Eisenhower Matrix	19
	Prioritization Strategies in Data Projects	20
	Managing Deadlines & Deliverables in Teams	21
	Productivity Tools: Agile, Scrum, Kanban	22
	Work-Life Balance in High-Performance Teams	23
	Overcoming Workplace Stress & Burnout	24
Unit 5	**Conflict Resolution & Negotiation**	**25-30 (6 hours)**
	Types of Workplace Conflicts & Resolution Strategies	25
	Negotiation Techniques & Influencing Skills	26
	Handling Difficult Conversations in the Workplace	27
	Power Dynamics & Ethical Leadership in Negotiation	28
	Conflict Resolution Strategies for Data Teams	29
	Case Study on Workplace Conflict Management	30
Unit 6	**Ethical Leadership & Professionalism**	**31-36 (6 hours)**
	Ethical Leadership in Data Science & AI	31
	Workplace Professionalism: Ethics & Etiquette	32

	Diversity, Equity, and Inclusion (DEI) in Organizations	33
	Social Responsibility & Leadership in Tech Companies	34
	Future of Leadership in a Data-Driven World	35
	Final Debate: AI & Ethics in the Workplace	36
Unit 7	**Final Assessment & Practical Applications**	**37-45 (9 hours)**
	Leadership Simulation: Managing a Data Science Team	37-38
	Case Study Analysis & Presentations	39-40
	Personal Development Plan: Career Roadmap	41
	Industry Speaker Session: Leadership Insights	42
	Mock Interviews & Workplace Role-Play	43
	Final Assessment (Theory & Case-Based Exam)	44-45

SUGGESTED READING:

- **"The 5 Levels of Leadership"** – John C. Maxwell
- **"Leadership and Self-Deception"** – The Arbinger Institute
- **"Mindset: The New Psychology of Success" – Carol S. Dweck**
- **"The First 90 Days"** – Michael D. Watkins
-

SEMESTER-VI

B.Sc. SEMESTER VI							
Type	**Subject Code**	**Subject (Theory)**	**L**	**T**	**P**	**Total Credit**	**Total Marks**
DSC	**TIU-UDS-MJ-T32301**	**Big Data Processing Techniques and Platforms**	**3**	**1**	**0**	**4**	**100**
DSC	**TIU-UDS-**	**Data Processing and**	**3**	**0**	**0**	**3**	**100**

	MJ-T32302	**Scrapping**					
DSC	**TIU-UDS-MJ-T32303**	**Ethical Hacking and Cyber Security**	**2**	**1**	**0**	**3**	**100**
Interdisciplinary	**TIU-UDS-MD-T3201**	**Management Information System**	**2**	**1**	**0**	**3**	**100**
OEC	**TIU-UDS-MI-S32201A**	**Open Elective - VI: Capstone Project on Machine Learning**	**0**	**0**	**3**	**3**	**100**
Internship	**TIU-UDS-MI-I32201**	**Internship, Project Work & Viva Voce**	**0**	**0**	**4**	**4**	**100**
		6th Semester Total				**20**	**600**

Paper 1: Big Data Processing Techniques and Platforms DSC: Discipline Specific Core (Course)

Course Objective: A comprehensive understanding of big data processing techniques, platforms, and best practices, enabling them to design, implement, and optimize big data processing systems for real-world applications. Learn about the different technologies and platforms used for big data processing, including batch processing, stream processing, and real- time processing.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO Number	Details
CO-1	Understand the fundamental concepts of Big Data, including its definition, characteristics (5Vs), and various data sources.
CO-2	Analyze real-world Big Data applications by exploring case studies from various domains such as transportation, healthcare, retail, and telecom.
CO-3	Identify challenges in Big Data collection, cleaning, and integration while exploring different data management approaches.
CO-4	Evaluate different data storage solutions, including relational databases (RDBMS), NoSQL databases, and distributed storage frameworks such as Hadoop.
CO-5	Apply Big Data processing techniques such as distributed computing, parallel computing, and the MapReduce framework to optimize large-scale data analysis.

CO-6	Develop a practical Big Data project by integrating data collection, storage, computation, and visualization techniques to address real-world problems effectively.

COURSE STRUCTURE:

Unit No.	Unit Title	Topics Covered	Duration (Hours)
1	**Introduction to Big Data**	1.1 What is Big Data?	**8**
		1.2 Characteristics of Big Data	
		1.3 Sources of Big Data	
2	**Big Data Use Cases**	2.1 Case study from Transportation domain	**10**
		2.2 Case study from Healthcare domain	
		2.3 Case study from Retail domain	
		2.4 Case study from Telecom domain	
3	**Challenges & Solutions**	3.1 Data collection: Data collection, cleaning, and integration	**14**
		3.2 Data storage: Options like RDBMS, NoSQL, Hadoop	
		3.3 Computation: Distributed and parallel computing, MapReduce	
		3.4 Analysis: Performance, Streaming, Visualization	
4	**Group Project**	Practical implementation of Big Data concepts through a real-world project	**8**

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO-1:	**3**	**1**	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**2**
CO-2:	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**
CO-3:	**2**	**3**	**2**	**1**	**2**	**3**	**3**	**2**	**2**	**3**
CO-4:	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**3**
CO-5:	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**
CO-6:	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**
AVERAGE	2.33	2.50	2.50	2.00	2.33	2.67	2.83	2.00	2.00	2.83

Suggested Readings for Big Data Processing Techniques & Platforms

1. **"Big Data: Principles and Best Practices of Scalable Real-Time Data Systems"** – Nathan Marz & James Warren
2. **"Hadoop: The Definitive Guide"** – Tom White
3. **"Big Data: A Revolution That Will Transform How We Live, Work, and Think"** – Viktor Mayer-Schönberger& Kenneth Cukier
4. **"Data-Intensive Text Processing with MapReduce"** – Jimmy Lin & Chris Dyer
5. **"Mining of Massive Datasets"** – Jure Leskovec, Anand Rajaraman, & Jeffrey Ullman
6. **"Big Data Analytics with Spark: A Practitioner's Guide to Using Spark for Large Scale Data Analysis"** – Mohammed Guller

Paper 2: Data Processing and Scrapping DSC: Discipline Specific Core (Course)

Course Objective:

1. Provide knowledge on data processing, collection, and transformation.
2. Develop skills in advanced data processing techniques such as batch and real-time processing.
3. Introduce data security concepts, malware, and encryption techniques.
4. Enable students to analyse and extract meaningful insights from large datasets.
5. Equip students with tools and technologies for web scraping and data manipulation.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO Number	Details
CO1	Identify various data types and collection methods
CO2	Execute data preparation and processing
CO3	Apply advanced data processing techniques
CO4	Conduct statistical data analysis
CO5	Design data storage and retrieval systems
CO6	Implement data security measures

COURSE CONTENT:

Unit	Unit Title	Topics Covered	Duration (Hours)
Unit 1	Introductory Concepts	Data types (numerical, categorical, textual), Data collection methods, Web scraping, Mobile apps, Social Networks	6
Unit 2	Data Preparation and Processing	Cleaning, Editing, Transcribing, Statistical adjustments, Analysis strategy selection	8
Unit 3	Advanced Processing Techniques	Batch vs. Real-time processing, Data mining, Data transformation, Pattern evaluation, Cluster analysis	10
Unit 4	Statistical Data Analysis	Correlation, Classification, Prediction, Outlier analysis, Data visualization techniques	9
Unit 5	Data Storage & Retrieval	Database/API integration, Data structures (Centralized/Distributed, Persistent/In-memory), Synchronous vs. Asynchronous	8

Unit 6	Data Security	Malware, Phishing, Encryption, Firewalls, Two-factor authentication, Denial of Service, SQL Injection	9

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	1	1	1	2	2	2	3	3
CO2	2	2	1	1	1	3	2	3	2	2
CO3	3	3	2	1	2	3	3	2	3	3
CO4	3	3	3	2	3	3	3	2	3	3
CO5	2	2	2	2	2	3	2	2	2	3
CO6	3	1	1	1	1	3	2	3	3	3
Average	3	2	2	1	2	3	2	2	3	3

Suggested Readings

1. **Han, J., Pei, J., & Kamber, M. (2011).***Data Mining: Concepts and Techniques (3rd ed.)*. Morgan Kaufmann.
2. **Provost, F., & Fawcett, T. (2013).***Data Science for Business: What You Need to Know About Data Mining and Data-Analytic Thinking*. O'Reilly Media.
3. **McKinney, W. (2017).***Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython (2nd ed.)*. O'Reilly Media.
4. **Shmueli, G., Bruce, P. C., Gedeck, P., & Patel, N. R. (2020).***Data Mining for Business Analytics: Concepts, Techniques, and Applications in R (3rd ed.)*. Wiley.
5. **Goodfellow, I., Bengio, Y., & Courville, A. (2016).***Deep Learning*. MIT Press.

Paper 3: Ethical Hacking and Cyber Security: Discipline Specific Core (Course)

COURSE OBJECTIVE:

The Ethical Hacking and Cyber Security course aims to equip students with the knowledge and practical skills required to identify vulnerabilities, protect digital assets, and implement security measures to prevent cyber threats.

CO No.	Course Outcome
CO1	Understand cyber security threats, ethical hacking principles, and legal frameworks.
CO2	Perform reconnaissance and information gathering using ethical hacking techniques.
CO3	Conduct network scanning, enumeration, and vulnerability assessment.
CO4	Apply system hacking and exploitation techniques to identify security flaws.
CO5	Secure web applications by identifying and mitigating security vulnerabilities.

CO6	Implement security measures for wireless, IoT, and cloud environments.

COURSE STRUCTURE:

Unit No.	Topics Covered	Sessions (Hours)
Unit 1	**Introduction to Cyber Security & Ethical Hacking**	**1-6 (6 hours)**
	Cyber Security Fundamentals: Concepts, Attacks, and Prevention	2
	Types of Hackers: White Hat, Black Hat, and Grey Hat	3
	Ethical Hacking: Definition, Scope, and Legal Framework	4
	Understanding Cyber Threats: Malware, Phishing, Ransomware	5
	Role of Ethical Hackers in Cyber Defense	6
Unit 2	**Footprinting& Reconnaissance**	**7-12 (6 hours)**
	Introduction to Footprinting: Active & Passive Methods	7
	Information Gathering Techniques: Whois, Nslookup, Nmap	8
	Google Dorking and OSINT Techniques	9
	Social Engineering Attacks & Prevention Strategies	10
	Footprinting Countermeasures	11
	Hands-on Practice: Footprinting Simulation	12
Unit 3	**Scanning & Enumeration**	**13-18 (6 hours)**
	Network Scanning: Types, Tools, and Techniques	13
	Port Scanning using Nmap, Netcat, and Zenmap	14
	Vulnerability Scanning: Nessus and OpenVAS	15
	Enumeration: SNMP, SMTP, SMB, and DNS Attacks	16

	Countermeasures for Scanning & Enumeration	17
	Hands-on Exercise: Network Scanning Simulation	18
Unit 4	**System Hacking & Exploitation**	**19-24 (6 hours)**
	Password Cracking: Brute Force, Dictionary, Rainbow Tables	19
	Privilege Escalation Techniques	20
	Keyloggers and Spyware: Detection and Prevention	21
	Metasploit Framework: Exploitation Techniques	22
	Anti-Forensics & Covering Tracks	23
	Hands-on Lab: Exploiting Vulnerabilities	24
Unit 5	**Web Application Security & Attacks**	**25-30 (6 hours)**
	SQL Injection: Types and Countermeasures	25
	Cross-Site Scripting (XSS) and Cross-Site Request Forgery (CSRF)	26
	Broken Authentication and Session Hijacking	27
	Web Application Firewalls (WAF) and Security Headers	28
	Secure Coding Practices for Web Applications	29
	Hands-on Lab: Testing Web Application Security	30
Unit 6	**Wireless, IoT & Cloud Security**	**31-36 (6 hours)**
	Wireless Hacking: WEP, WPA, WPA2 Attacks	31
	Bluetooth & IoT Security Vulnerabilities	32
	Cloud Security: Threats and Best Practices	33
	Cloud Penetration Testing	34

	Secure Configuration and Hardening of Cloud Environments	35
	Hands-on Exercise: Securing IoT and Cloud Systems	36
Unit 7	**Final Project & Industry Applications**	**37-45 (9 hours)**
	Ethical Hacking Capstone Project	37-38
	Case Study Analysis & Presentations	39-40
	Industry Speaker Session: Cyber Security Insights	41
	Capture The Flag (CTF) Challenge	42
	Mock Cyber Attack & Incident Response	43
	Final Exam (Theory & Practical)	44-45

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	-	-	-	-	-	-	**2**	-	**3**	**2**
CO2	-	**2**	-	-	-	-	**3**	-	**2**	-
CO3	-	**2**	-	-	-	**2**	**3**	-	-	-
CO4	-	**3**	-	-	-	**2**	**3**	-	-	-
CO5	-	**2**	-	-	**2**	-	**3**	**2**	**2**	-
CO6	-	**3**	-	-	-	**2**	**3**	-	**3**	**2**
AVERAGE	**0**	**2.40**	**0.00**	**0.00**	**2**	**2**	**2.83**	**2**	**0**	**2**

SUGGESTED READING:

 "The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws" – Dafydd Stuttard& Marcus Pinto

 "Hacking: The Art of Exploitation" – Jon Erickson

 "CEH Certified Ethical Hacker All-in-One Exam Guide" – Matt Walker

 "Metasploit: The Penetration Tester's Guide" – David Kennedy, Jim O'Gorman, Devon Kearns, Mati Aharoni

 "The Basics of Hacking and Penetration Testing" – Patrick Engebretson

Paper 4: Management Information System: Interdisciplinary (Course)

The primary objectives of this course are to:

1. Understand the fundamental concepts of Management Information Systems (MIS) and their role in decision-making.
2. Analyze the various types of information systems used in organizations.
3. Explore database management, cloud computing, and data security in MIS.
4. Understand the application of MIS in business strategy and organizational growth.
5. Develop hands-on skills in MIS software and tools.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO No.	Course Outcome
CO1	Understand the role of MIS in business and organizations.
CO2	Apply database management and cloud computing in MIS.
CO3	Analyze ERP and decision support systems for business growth.
CO4	Implement cybersecurity strategies and ethical practices in MIS.
CO5	Develop business strategies using MIS and emerging technologies.
CO6	Evaluate the future trends and applications of MIS in various industries.

COURSE STRUCTURE:

Unit No.	Topics Covered	Sessions (Hours)
Unit 1	**Introduction to MIS and Business Information Systems**	**1-6 (6 hours)**
	Overview of MIS: Definition, Components, and Functions	1
	Evolution of Information Systems in Business	2
	Types of Information Systems: TPS, MIS, DSS, ESS	03-Apr
	Role of MIS in Business Decision-Making	5
	Real-World Examples of MIS Implementation	6
Unit 2	**Data Management & Database Systems in MIS**	**7-12 (6 hours)**

	Introduction to Database Management Systems (DBMS)	7
	Relational Databases: SQL and NoSQL Concepts	8
	Cloud Computing & Big Data in MIS	9
	Data Warehousing and Data Mining	10
	Hands-on with Database Tools (MySQL, MongoDB)	11
	Ethical & Legal Aspects of Data Management	12
Unit 3	**Enterprise Resource Planning (ERP) & Decision Support Systems (DSS)**	**13-18 (6 hours)**
	Introduction to ERP Systems	13
	Components and Benefits of ERP	14
	Decision Support Systems (DSS) & Business Intelligence	15
	Implementation of ERP in Large Organizations	16
	Hands-on with ERP Software (SAP, Oracle)	17
	Future Trends in ERP and DSS	18
Unit 4	**Information Security & Ethical Concerns in MIS**	**19-24 (6 hours)**
	Introduction to Cybersecurity in MIS	19
	Threats to Information Security	20
	Security Frameworks and Policies	21
	Risk Management and Disaster Recovery Planning	22
	Ethical Issues in MIS: Privacy & Data Protection	23
	Case Study on Information Security in Business	24
Unit 5	**MIS in Business Strategy & Innovation**	**25-30 (6 hours)**
	Role of MIS in Strategic Planning	25
	E-Commerce & Digital Business Models	26
	Artificial Intelligence & Machine Learning in MIS	27

	MIS for Competitive Advantage	28
	MIS in Marketing, Finance, and Supply Chain	29
	Case Study on MIS-Driven Business Success	30
Unit 6	**Emerging Trends & Future of MIS**	**31-36 (6 hours)**
	Role of IoT in MIS	31
	Blockchain Technology in MIS	32
	MIS in Smart Cities & Digital Governance	33
	Automation & Robotics in Business Information Systems	34
	Cloud-Based MIS and SaaS Models	35
	Future Research Areas in MIS	36
Unit 7	**Final Project & Practical Implementation**	**37-45 (9 hours)**
	MIS-Based Capstone Project	37-38
	Case Study Analysis & Presentations	39-40
	Industry Speaker Session: MIS in Action	41
	MIS Implementation in a Simulated Environment	42
	Real-World Problem-Solving Using MIS	43
	Final Exam (Theory & Practical)	44-45

SUGGESTED READING:

 "Management Information Systems: Managing the Digital Firm" – *Kenneth C. Laudon & Jane P. Laudon*

- Covers core MIS concepts, digital transformation, and emerging technologies.

 "Information Systems for Managers: Text and Cases" – *Gabriele Piccoli & Federico Pigni*

- Focuses on MIS from a business strategy perspective.

 "Enterprise Resource Planning (ERP)" – *Alexis Leon*

- A detailed exploration of ERP systems and their role in MIS.

 "Principles of Information Systems" – *Ralph Stair & George Reynolds*

- Introduces information systems fundamentals with real-world applications

LAB PAPER: Open Elective - VI: Capstone Project on Machine Learning

The **Capstone Project on Machine Learning** is designed to provide students with hands-on experience in solving real-world problems using **ML techniques**. The primary objectives are:

1. Understand the complete lifecycle of a Machine Learning (ML) project.
2. Develop skills in problem formulation, data collection, and pre-processing.
3. Apply appropriate ML algorithms for classification, regression, and clustering.
4. Optimize and evaluate model performance using appropriate metrics.
5. Work with real-world datasets and deploy ML models.
6. Develop teamwork, research, and technical report-writing skills.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO No.	Course Outcome
CO1	Define the problem statement and select relevant ML models.
CO2	Pre-process and clean real-world datasets for ML applications.
CO3	Train and optimize supervised learning models for predictions.
CO4	Implement clustering and dimensionality reduction techniques.
CO5	Apply deep learning models for complex AI applications.
CO6	Deploy ML models and evaluate real-world performance.

COURSE STRUCTURE:

Unit No.	Topics Covered	Sessions (Hours)
Unit 1	**Introduction to Capstone Project & ML Overview**	**1-6 (6 hours)**
	Overview of Machine Learning Project Lifecycle	1
	Selection of Capstone Project Topics	2
	Understanding Business Problems & ML Applications	3
	Setting Objectives & Problem Definition	4
	Dataset Selection & Sources (Kaggle, UCI, APIs)	5

	Tools & Frameworks (Python, TensorFlow, Scikit-Learn)	6
Unit 2	**Data Collection, Cleaning & Preprocessing**	**7-12 (6 hours)**
	Data Collection Strategies & APIs	7
	Handling Missing Data & Outliers	8
	Feature Engineering & Selection	9
	Data Normalization & Scaling	10
	Exploratory Data Analysis (EDA) & Visualization	11
	Hands-on with Pandas, NumPy, Seaborn & Matplotlib	12
Unit 3	**Supervised Learning Algorithms**	**13-18 (6 hours)**
	Linear & Logistic Regression	13
	Decision Trees & Random Forests	14
	Support Vector Machines (SVM)	15
	Naïve Bayes & K-Nearest Neighbors (KNN)	16
	Hyperparameter Tuning (Grid Search, Random Search)	17
	Hands-on Lab: Implementing Supervised Models	18
Unit 4	**Unsupervised Learning & Feature Engineering**	**19-24 (6 hours)**
	K-Means & Hierarchical Clustering	19
	Principal Component Analysis (PCA) & Dimensionality Reduction	20
	Anomaly Detection using Isolation Forest	21
	Association Rule Mining (Apriori, FP-Growth)	22
	Feature Engineering for Model Performance	23

	Hands-on Lab: Implementing Clustering & Dimensionality Reduction	24
Unit 5	**Deep Learning & Advanced ML Concepts**	**25-30 (6 hours)**
	Introduction to Neural Networks & Deep Learning	25
	Convolutional Neural Networks (CNN) for Image Processing	26
	Recurrent Neural Networks (RNN) & LSTMs for Time Series	27
	Transfer Learning & Pretrained Models	28
	AutoML& Model Optimization	29
	Hands-on Lab: Implementing Deep Learning Models	30
Unit 6	**Model Evaluation & Performance Optimization**	**31-36 (6 hours)**
	Evaluating Model Performance (Accuracy, Precision, Recall, F1-score)	31
	Cross-Validation & Overfitting Prevention	32
	Model Interpretability (SHAP, LIME)	33
	Deployment Strategies: Flask, FastAPI, Streamlit	34
	Real-Time Model Monitoring & Retraining	35
	Model Deployment on Cloud (AWS, GCP, Azure)	36
Unit 7	**Final Capstone Project Execution**	**37-45 (9 hours)**
	Project Implementation Phase 1: Data Collection & Preprocessing	37-38
	Model Selection, Training & Evaluation	39-40
	Project Deployment & Demonstration	41
	Capstone Report Writing & Documentation	42

	Peer Review & Feedback Session	43
	Final Presentation & Viva	44-45

Suggested Readings :

- **"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" – Aurélien Géron**
- **"Pattern Recognition and Machine Learning" – Christopher Bishop**
- **"Deep Learning" – Ian Goodfellow, Yoshua Bengio, Aaron Courville**
- **"Machine Learning Engineering" – Andriy Burkov**

SEMESTER-VII

Course Structure of B.Sc. (H) in Data Science							
B.Sc. SEMESTER VII							
Type	**Subject Code**	**Subject (Theory)**	**L**	**T**	**P**	**Total Credit**	**Total Marks**
DSC	**TIU-UDS-MJ-T41401**	**Research Methodology**	**3**	**1**	**0**	**4**	**100**
DSC	**TIU-UDS-MJ-T41402**	**Software engineering and Project Management**	**3**	**1**	**0**	**4**	**100**
DSC	**TIU-UDS-MJ-T41403**	**Systematic Literature Review and Bibliometric Analysis**	**3**	**1**	**0**	**4**	**100**
OEC	**TIU-UDS-MI-T41301A**	**Open Elective - VII: Digital Marketing and E-Commerce in Data Science**	**2**	**2**	**0**	**4**	**100**
Internship	**TIU-UDS-MI-I41301**	**Internship, Project Work & Viva Voce**	**0**	**0**	**4**	**4**	**100**
		7th Semester Total				**20**	**600**

Paper 1 Research Methodology DSC: Discipline Specific Core (Course)

COURSE OBJECTIVE:

1. Understand the fundamentals of research methodology and its importance in data science.
2. Learn how to formulate research problems, hypotheses, and objectives.
3. Explore various data collection methods and research designs.
4. Apply statistical techniques for data analysis and interpretation.
5. Develop skills in writing research reports, thesis, and academic papers.
6. Understand ethical considerations and best practices in research.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO No.	Course Outcome
CO1	Understand the importance and applications of research methodology in data science.
CO2	Formulate research problems, hypotheses, and objectives.
CO3	Design research frameworks and collect data using various methods.
CO4	Apply statistical methods for data analysis in research studies.
CO5	Integrate machine learning techniques in research methodology.
CO6	Write, present, and publish research work following ethical guidelines.

COURSE STRUCTURE:

Unit No.	Topics Covered	Sessions (Hours)
Unit 1	**Introduction to Research Methodology**	**1-6 (6 hours)**
	Meaning, Objectives, and Types of Research	1
	Research in Data Science: Importance and Applications	2
	Scientific Approach to Research	3
	Characteristics of Good Research	4
	Research Process and Steps in Research	5
	Challenges in Research for Data Science	6
Unit 2	**Research Problem & Hypothesis Formulation**	**7-12 (6 hours)**
	Identifying and Defining a Research Problem	7
	Literature Review & Gap Identification	8
	Defining Research Objectives	9
	Formulating Hypothesis: Types and Characteristics	10
	Testing Hypothesis in Data Science	11

	Case Study on Research Hypotheses	12
Unit 3	**Research Design & Data Collection Methods**	**13-18 (6 hours)**
	Introduction to Research Design	13
	Experimental, Descriptive, and Exploratory Research	14
	Sampling Methods and Techniques	15
	Data Collection Methods: Primary & Secondary	16
	Survey Methods, Interviews, and Questionnaires	17
	Ethical Issues in Data Collection	18
Unit 4	**Statistical Methods for Data Analysis**	**19-24 (6 hours)**
	Descriptive and Inferential Statistics	19
	Probability Distributions & Hypothesis Testing	20
	Correlation & Regression Analysis	21
	ANOVA, Chi-Square & t-Tests	22
	Data Visualization in Research (Matplotlib, Seaborn)	23
	Statistical Tools for Research (SPSS, R, Python)	24
Unit 5	**Machine Learning in Research Methodology**	**25-30 (6 hours)**
	Role of ML in Research	25
	Applying Supervised and Unsupervised Learning in Research	26
	Feature Selection and Data Preprocessing	27
	Model Evaluation Metrics	28
	AI-driven Research Methods	29
	Case Study: ML-Based Research Papers	30
Unit 6	**Research Ethics & Academic Integrity**	**31-36 (6 hours)**

	Ethical Issues in Research	31
	Plagiarism & Academic Integrity	32
	Copyright and Intellectual Property Rights	33
	Research Ethics in Data Science	34
	Open Science & Reproducibility in Research	35
	Case Study: Ethical Issues in AI Research	36
Unit 7	**Research Writing & Publication Process**	**37-45 (9 hours)**
	Writing a Research Paper & Thesis	37
	Formatting & Referencing (APA, IEEE, Harvard)	38
	Journal Selection & Impact Factor	39
	Peer Review Process & Plagiarism Check	40
	Writing Abstracts & Conclusions	41
	Submitting Research for Conferences & Journals	42
	Final Research Presentation & Viva	43
	Feedback & Research Refinement	44
	Course Wrap-up & Future Research Opportunities	45

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**3**	**-**	**-**	**-**	**2**	**-**	**2**	**-**	**2**	**2**
CO2	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**-**	**2**
CO3	**3**	**-**	**-**	**-**	**2**	**3**	**3**	**-**	**-**	**-**
CO4	**3**	**-**	**-**	**-**	**-**	**2**	**3**	**-**	**-**	**-**
CO5	**2**	**2**	**3**	**2**	**-**	**-**	**3**	**-**	**-**	**2**
CO6	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**3**
AVERAGE	**0**	**2.00**	**0.00**	**0.00**	**2**	**2.5**	**2.67**	**2.5**	**0**	**2.25**

SUGGESTED READING:

- **"Research Methodology: Methods and Techniques"** – C.R. Kothari
- **"The Craft of Research"** – Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams
- **"Designing and Conducting Mixed Methods Research"** – John W. Creswell
- **"Writing for Social Scientists"** – Howard S. Becker
- **"Python for Data Analysis"** – Wes McKinney

Paper 2: Software Engineering and Project Management DSC: Discipline Specific Core (Course)

COURSE OBJECTIVE:

This course introduces students to the fundamental concepts of **Software Engineering (SE)** and **Project Management (PM)** with a focus on **data science applications**. The primary objectives are:

1. Understand **Software Development Life Cycle (SDLC)** and software engineering principles.
2. Learn about **agile methodologies, DevOps, and software quality assurance**.
3. Explore **software design, architecture, and documentation techniques**.
4. Apply **project management frameworks** like Agile, Scrum, and Waterfall.
5. Understand **risk assessment, resource allocation, and team management** in projects.
6. Implement **real-world project management strategies in data science projects**.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO No.	Course Outcome
CO1	Understand the fundamentals of software engineering & SDLC.
CO2	Apply software design principles and architectures.
CO3	Implement Agile methodologies and DevOps practices.
CO4	Conduct software testing and ensure software quality assurance.
CO5	Apply project management techniques in software projects.
CO6	Manage real-world software projects using Agile frameworks.

COURSE STRUCTURE:

Unit No.	Topics Covered	Sessions (Hours)
Unit 1	**Introduction to Software Engineering & SDLC**	**1-6 (6 hours)**

	Software Engineering: Overview & Importance	1
	Software Development Life Cycle (SDLC)	2
	SDLC Models: Waterfall, Agile, Spiral, V-Model	3
	Role of Software Engineering in Data Science Projects	4
	Software Requirements: Functional vs Non-Functional	5
	Case Study: Real-world Software Engineering Challenges	6
Unit 2	**Software Design & Architecture**	**7-12 (6 hours)**
	Principles of Software Design & Development	7
	UML Diagrams & Software Documentation	8
	Software Architectures: MVC, Microservices, Monolithic	9
	API Design & Integration in Software Systems	10
	Design Thinking & Prototyping	11
	Case Study: Software Architecture in Data Science	12
Unit 3	**Agile Methodologies & DevOps**	**13-18 (6 hours)**
	Introduction to Agile Methodology	13
	Scrum Framework: Roles, Events, and Artifacts	14
	DevOps: Concepts & Implementation	15
	Continuous Integration & Continuous Deployment (CI/CD)	16
	Version Control Systems (Git, GitHub, GitLab)	17
	Hands-on Lab: Implementing Agile in Data Science	18

Unit 4	**Software Testing & Quality Assurance**	**19-24 (6 hours)**
	Software Testing Fundamentals: Manual & Automated Testing	19
	Unit Testing, Integration Testing, and System Testing	20
	Test-Driven Development (TDD) &Behavior-Driven Development (BDD)	21
	Software Quality Metrics & ISO Standards	22
	Bug Tracking & Debugging Techniques	23
	Case Study: Software Testing in Data Science Applications	24
Unit 5	**Introduction to Project Management**	**25-30 (6 hours)**
	Basics of Project Management & Project Life Cycle	25
	Project Scheduling & Work Breakdown Structure (WBS)	26
	Resource Allocation & Budgeting in Projects	27
	Risk Management in Software Projects	28
	Stakeholder Analysis & Team Collaboration	29
	Case Study: Project Management in Software Development	30
Unit 6	**Agile Project Management & Scrum Implementation**	**31-36 (6 hours)**
	Agile Project Management Tools (Jira, Trello, Asana)	31
	Sprint Planning & Execution in Scrum	32
	Kanban Boards for Project Tracking	33
	Documentation & Reporting in Agile Projects	34
	Time Management & Productivity in Projects	35

	Case Study: Agile in Real-World Software Development	36
Unit 7	**Capstone Project: Software Engineering & Project Management**	**37-45 (9 hours)**
	Project Proposal & Requirement Analysis	37
	Software Design & System Architecture Planning	38
	Development, Testing & Quality Assurance	39
	Agile Implementation & Sprint Reviews	40
	Project Deployment & Performance Evaluation	41
	Final Project Presentation & Documentation	42
	Peer Review & Feedback Session	43
	Course Wrap-up & Future Industry Trends	44
	Final Viva & Project Defense	45

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	-	**2**	-	-	-	-	**2**	-	**2**	**2**
CO2	-	**3**	-	**2**	-	-	**3**	-	-	**2**
CO3	-	**3**	-	**3**	-	-	**3**	**2**	-	**3**
CO4	-	**2**	-	-	-	-	**3**	-	-	**2**
CO5	-	-	-	-	-	**2**	**3**	**2**	**2**	**3**
CO6	-	**2**	-	**3**	-	**2**	**3**	**2**	**3**	**3**
AVERAGE	**0**	**2.40**	**0.00**	**0.00**	**0**	**2**	**2.83**	**2**	**0**	**2.5**

SUGGESTED READING:

- **"Software Engineering: A Practitioner's Approach"** – Roger Pressman
- **"The Art of Agile Development"** – James Shore
- **"Agile Estimating and Planning"** – Mike Cohn
- **"Project Management for the Unofficial Project Manager"** – Kory Kogon

Paper 3: Systematic Literature Review and Bibliometric Analysis DSC: Discipline Specific Core (Course)

This course introduces students to the fundamental concepts of **Software Engineering (SE)** and **Project Management (PM)** with a focus on **data science applications**. The primary objectives are:

1. Understand **Software Development Life Cycle (SDLC)** and software engineering principles.
2. Learn about **agile methodologies, DevOps, and software quality assurance**.
3. Explore **software design, architecture, and documentation techniques**.
4. Apply **project management frameworks** like Agile, Scrum, and Waterfall.
5. Understand **risk assessment, resource allocation, and team management** in projects.
6. Implement **real-world project management strategies in data science projects**.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO No.	Course Outcome
CO1	Understand the fundamentals of software engineering & SDLC.
CO2	Apply software design principles and architectures.
CO3	Implement Agile methodologies and DevOps practices.
CO4	Conduct software testing and ensure software quality assurance.
CO5	Apply project management techniques in software projects.
CO6	Manage real-world software projects using Agile frameworks.

COURSE STRUCTURE:

Unit No.	Topics Covered	Sessions (Hours)
Unit 1	**Introduction to Software Engineering & SDLC**	**1-6 (6 hours)**
	Software Engineering: Overview & Importance	1
	Software Development Life Cycle (SDLC)	2
	SDLC Models: Waterfall, Agile, Spiral, V-Model	3
	Role of Software Engineering in Data Science Projects	4
	Software Requirements: Functional vs Non-Functional	5
	Case Study: Real-world Software Engineering Challenges	6

Unit 2	**Software Design & Architecture**	**7-12 (6 hours)**
	Principles of Software Design & Development	7
	UML Diagrams & Software Documentation	8
	Software Architectures: MVC, Microservices, Monolithic	9
	API Design & Integration in Software Systems	10
	Design Thinking & Prototyping	11
	Case Study: Software Architecture in Data Science	12
Unit 3	**Agile Methodologies & DevOps**	**13-18 (6 hours)**
	Introduction to Agile Methodology	13
	Scrum Framework: Roles, Events, and Artifacts	14
	DevOps: Concepts & Implementation	15
	Continuous Integration & Continuous Deployment (CI/CD)	16
	Version Control Systems (Git, GitHub, GitLab)	17
	Hands-on Lab: Implementing Agile in Data Science	18
Unit 4	**Software Testing & Quality Assurance**	**19-24 (6 hours)**
	Software Testing Fundamentals: Manual & Automated Testing	19
	Unit Testing, Integration Testing, and System Testing	20
	Test-Driven Development (TDD) &Behavior-Driven Development (BDD)	21
	Software Quality Metrics & ISO Standards	22
	Bug Tracking & Debugging Techniques	23
	Case Study: Software Testing in Data Science Applications	24
Unit 5	**Introduction to Project Management**	**25-30 (6 hours)**
	Basics of Project Management & Project Life Cycle	25
	Project Scheduling & Work Breakdown Structure (WBS)	26
	Resource Allocation & Budgeting in Projects	27

	Risk Management in Software Projects	28
	Stakeholder Analysis & Team Collaboration	29
	Case Study: Project Management in Software Development	30
Unit 6	**Agile Project Management & Scrum Implementation**	**31-36 (6 hours)**
	Agile Project Management Tools (Jira, Trello, Asana)	31
	Sprint Planning & Execution in Scrum	32
	Kanban Boards for Project Tracking	33
	Documentation & Reporting in Agile Projects	34
	Time Management & Productivity in Projects	35
	Case Study: Agile in Real-World Software Development	36
Unit 7	**Capstone Project: Software Engineering & Project Management**	**37-45 (9 hours)**
	Project Proposal & Requirement Analysis	37
	Software Design & System Architecture Planning	38
	Development, Testing & Quality Assurance	39
	Agile Implementation & Sprint Reviews	40
	Project Deployment & Performance Evaluation	41
	Final Project Presentation & Documentation	42
	Peer Review & Feedback Session	43
	Course Wrap-up & Future Industry Trends	44
	Final Viva & Project Defense	45

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**3**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**2**	**2**
CO2	**-**	**3**	**-**	**-**	**-**	**3**	**2**	**-**	**-**	**2**
CO3 -	**2**	**2**	**3**	**2**	**-**	**-**	**3**	**-**	**-**	**2**
CO4	**-**	**-**	**2**	**3**	**-**	**-**	**3**	**-**	**-**	**3**
CO5	**2**	**-**	**-**	**-**	**3**	**-**	**3**	**2**	**-**	**2**

CO6	**3**	**-**	**-**	**-**	**-**	**3**	**2**	**-**	**-**	**-**
AVERAGE	**2.5**	**2.5**	**2.5**	**2.5**	**3**	**2.66**	**2.5**	**2**	**2**	**2.2**

SUGGESTED READING:

- **"Software Engineering: A Practitioner's Approach"** – Roger Pressman
- **"The Art of Agile Development"** – James Shore
- **"Agile Estimating and Planning"** – Mike Cohn
- **"Project Management for the Unofficial Project Manager"** – Kory Kogon

PAPER 4: Open Elective - VII: Digital Marketing and E-Commerce in Data Science

COURSE OBJECTIVE:

This course integrates **Digital Marketing, E-Commerce, and Data Science** concepts to equip students with the necessary analytical skills for data-driven marketing decisions. The primary objectives are:

1. Understand the fundamentals of **Digital Marketing and E-Commerce** and their role in modern businesses.
2. Learn how **data analytics** enhances digital marketing strategies and customer engagement.
3. Apply **machine learning and AI** in digital advertising, SEO, and recommendation systems.
4. Explore **consumer behavior analytics**, market segmentation, and trend forecasting.
5. Learn how to use **web analytics tools** like Google Analytics and social media metrics for performance measurement.
6. Gain hands-on experience in **data-driven marketing campaigns and e-commerce optimization**.

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO No.	Course Outcome
CO1	Understand the fundamentals of digital marketing & e-commerce.
CO2	Apply SEO & SEM strategies using data-driven insights.
CO3	Analyse social media marketing & influencer impact using data science.
CO4	Use AI & analytics for customer segmentation & personalization.
CO5	Evaluate e-commerce performance & web analytics.
CO6	Implement real-world digital marketing campaigns using data analytics.

COURSE STRUCTURE:

Unit No.	Topics Covered	Sessions (Hours)
Unit 1	**Introduction to Digital Marketing & E-Commerce**	**1-6 (6 hours)**
	Evolution and Importance of Digital Marketing	1
	Fundamentals of E-Commerce and Online Business Models	2
	Role of Data Science in Digital Marketing	3
	Key Digital Marketing Channels (SEO, SEM, Email, Social Media)	4
	Key Performance Indicators (KPIs) in Digital Marketing	5
	Case Study: Successful E-Commerce Data Strategies	6
Unit 2	**SEO & Search Engine Marketing (SEM)**	**7-12 (6 hours)**
	Basics of SEO: On-page & Off-page Optimization	7
	Keyword Research & Competitive Analysis	8
	Google Ads & Pay-Per-Click (PPC) Advertising	9
	Data-Driven SEO Strategies & A/B Testing	10
	AI-based SEO & Voice Search Optimization	11
	Case Study: SEO for E-Commerce Websites	12
Unit 3	**Social Media & Influencer Marketing**	**13-18 (6 hours)**
	Understanding Social Media Marketing (SMM)	13
	Data-Driven Content Creation & Engagement Strategies	14
	Sentiment Analysis for Social Media Campaigns	15
	Predictive Analytics for Viral Content & Trends	16
	Influencer Marketing & ROI Measurement	17
	Case Study: Social Media Strategies of Top Brands	18

Unit 4	**Consumer Analytics & Personalization**	**19-24 (6 hours)**
	Understanding Consumer Behavior Using Data Science	19
	Customer Segmentation & Targeting	20
	Recommendation Systems for E-Commerce	21
	Personalization Strategies in Digital Marketing	22
	Churn Prediction & Customer Retention Analysis	23
	Case Study: Personalization in Amazon & Netflix	24
Unit 5	**E-Commerce Analytics & Performance Measurement**	**25-30 (6 hours)**
	Introduction to Web Analytics & Google Analytics	25
	Understanding Customer Journeys & Funnels	26
	Conversion Rate Optimization (CRO)	27
	Clickstream Data Analysis for E-Commerce	28
	Data-Driven Decision Making in Online Retail	29
	Case Study: E-Commerce Metrics and KPIs	30
Unit 6	**Email & Mobile Marketing Strategies**	**31-36 (6 hours)**
	Email Marketing Automation & Data Analytics	31
	A/B Testing for Email & Mobile Marketing	32
	Mobile App Analytics & User Engagement	33
	SMS Marketing & Push Notifications	34
	Best Practices in Data Privacy & GDPR Compliance	35
	Case Study: Effective Email & Mobile Marketing Strategies	36
Unit 7	**Capstone Project: Data-Driven Digital Marketing Strategy**	**37-45 (9 hours)**

	Selecting a Real-World Business for Digital Marketing	37
	Conducting Market & Competitor Analysis	38
	Implementing SEO, SEM, and Content Strategy	39
	Running Social Media Ad Campaigns &Analyzing Performance	40
	Data Collection & Consumer Insights Analysis	41
	Final Project Presentation & Performance Review	42
	Revising & Optimizing Marketing Strategy Based on Data	43
	Course Wrap-up & Future Digital Marketing Trends	44
	Final Viva & Marketing Campaign Defense	45

COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**	**2**
CO2	**2**	**2**	**-**	**-**	**3**	**2**	**3**	**-**	**-**	**3**
CO3	**2**	**-**	**2**	**-**	**3**	**2**	**3**	**-**	**2**	**2**
CO4	**3**	**2**	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**3**
CO5	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**-**	**-**	**3**
CO6	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**3**
AVERAGE	**2.5**	**2.25**	**2.25**	**2.67**	**3**	**2**	**2.83**	**3**	**2**	**2.67**

SUGGESTED READING:

- **"Digital Marketing: Strategy, Implementation and Practice"** – Dave Chaffey
- **"Predictive Marketing: Easy Ways to Use Big Data"** – Omer Artun
- **"Lean Analytics"** – Alistair Croll
- **"Google Analytics Breakthrough"** – Feras Alhlou

SEMESTER-VIII

B.Sc. SEMESTER VIII							
Type	Subject Code	Subject (Theory)	L	T	P	Total Credit	Total Marks
DSC	TIU-UDS-MJ-T42401	Graph Theory and Image processing	3	1	0	4	100
DSC	TIU-UDS-MJ-T42402	Computer application and statistical tools for research	3	1	0	4	100
DSC	TIU-UDS-MJ-T42403	Financial Analytics and Case Study	2	2	0	4	100
Internship	TIU-UDS-MI-I42301	Research Project & Dissertation and Grand Viva	0	0	4	4	100
Internship	TIU-UDS-MI-I42302	Report Writing & Research Ethics and Skill Development	0	0	4	4	100
		8th Semester Total				20	500

Paper 1 Graph Theory and Image Processing DSC: Discipline Specific Core (Course)

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO No.	Course Outcome (CO)
CO1	Understand and explain the fundamental concepts of graphs, including basic definitions of graphs, multigraphs, and chromatic numbers.
CO2	Analyze and apply adjacency matrices, graph isomorphism, decompositions, graph complements, and vertex coloring techniques.
CO3	Apply algorithms to find paths, cycles, and trails in graphs, and solve problems involving Eulerian circuits, vertex degrees, and bipartite subgraphs.
CO4	Understand the concept of trees in graph theory, and solve problems involving spanning trees, 2-switches, graph distance, and center.
CO5	Analyze and implement graph optimization algorithms such as Kruskal's, Prim's, and Dijkstra's algorithms.
CO6	Understand the fundamental steps in digital image processing, explore image components, and apply techniques in sampling, quantization, and image enhancement.

COURSE STRUCTURE:

Unit	Topic	Subtopic	Hours
Unit 1	Fundamental Concepts of Graphs	1.1 Fundamental concepts of graphs	12
		1.2 Basic definitions of graphs and multigraphs, chromatic number	
		1.3 Adjacency matrices	

		1.4 Isomorphism, decompositions, graph complements, vertex coloring	
		1.5 Chromatic number	
Unit 2	Graph Algorithms	2.1 Paths, cycles, and trails; Eulerian circuits	12
		2.2 Vertex degrees and counting; large bipartite subgraphs, directed graphs	
		2.3 Trees, Basics: equivalent characterizations of trees	
		2.4 Spanning trees and 2-switches	
		2.5 Distance and centre	
		2.6 Optimization: Kruskal's, Prim's and Dijkstra's Algorithm	
Unit 3	Digital Image Processing	3.1 Fundamental Steps in Digital Image Processing	12
		3.2 Components of an Image Processing System	
		3.3 Sampling and Quantization, Representing Digital Images (Data structure)	
		3.4 Some Basic Relationships between Pixels - Neighbours and Connectivity	
		3.5 Applications of Image Processing: Medical imaging, Robot vision, Character recognition, Remote Sensing	
Unit 4	Image Enhancement	4.1 Some Basic Gray Level Transformations	12
		4.2 Histogram Processing, Enhancement Using Arithmetic/Logic Operations	
		4.3 Basics of Spatial Filtering, Smoothing Spatial Filters	
		4.4 Sharpening Spatial Filters, Combining Spatial Enhancement Methods	
Unit 5	Image Enhancement in Frequency Domain	5.1 Image Enhancement in Frequency Domain: Introduction, Fourier Transform	12
		5.2 Discrete Fourier Transform (DFT), Properties of DFT	
		5.3 Discrete Cosine Transform (DCT), Image filtering in frequency domain	

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	2	1	1	1	2	2	2	2
CO2	2	2	2	2	1	2	3	2	2	3
CO3	2	1	2	1	1	2	3	2	2	3
CO4	1	3	1	2	1	3	2	2	2	3
CO5	2	2	1	2	1	3	3	3	2	3
CO6	2	3	2	3	1	3	3	2	2	3
AVERAGE	1.83	2	1.67	1.83	1	2.33	2.7	2.17	2	2.83

Suggested Reading:

1. **Introduction to Graph Theory" by Douglas B. West**
2. **"Fundamentals of Digital Image Processing" by Anil K. Jain**

Paper 2: Computer application and Statistical Tools DSC: Discipline Specific Core (Course)

Course Outcomes (COs): After completion of the course, the students shall be able to:

CO No.	Course Outcome (CO)
CO1	Understand and apply various sampling techniques, including point and interval estimation, to gather and analyze data accurately.
CO2	Apply probability theory and work with different theoretical distributions such as Binomial, Poisson, Exponential, Beta, and Normal distributions.
CO3	Develop hypotheses, perform hypothesis testing, and analyze significance tests for both attributes and variables using large sample data.
CO4	Conduct regression and correlation analysis, including multiple regression, and apply statistical quality control techniques to improve processes.
CO5	Use non-parametric tests like the Chi-Square Test, Sign Test, Median Test, and F Test to analyze data when parametric assumptions are not met.
CO6	Understand and apply Analysis of Variance (ANOVA) and Multivariate Analysis Techniques to compare means and analyze complex data sets.

COURSE STRUCTURE:

Unit	Topic	Subtopic	Hours
Unit 1	Sampling Theory	1.1 Sampling and Sample Design	12
		1.2 Introduction and Types of Sampling	
		1.3 Point Estimation and Interval Estimation	
		1.4 Sampling methods	
		1.5 Point Estimation and Interval Estimation	
Unit 2	Probability Distributions	2.1 Probability and Theoretical Distribution	12
		2.2 Approaches to Probability	
		2.3 Theorems of Probability	
		2.4 Binomial and Poisson distribution	
		2.5 Exponential, Beta & Normal Distribution	
Unit 3	Testing Hypothesis	3.1 Hypothesis Testing and Significance Tests in Attributes & Variables	12

		3.2 Procedure of Testing a Hypothesis	
		3.3 Significance Test in Attributes	
		3.4 Significance Test in Variables (Large Samples)	
Unit 4	Regression Analysis	4.1 Regression, Correlation and Statistical Quality Control	12
		4.2 Partial & Multiple Correlation	
		4.3 Multiple Regression Analysis	
		4.4 Types and Techniques of Statistical Quality Control	
		4.5 Control Charts for Attributes and Variables	
Unit 5	Parametric and Non-Parametric Test	5.1 Non Parametric Tests and Analysis of Variance	12
		5.2 Chi-Square Test	
		5.3 Sign Test & Median Test	
		5.4 F Test / Multivariate Analysis Technique	
		5.5 Analysis of Variance (ANNOVA)	

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	2	1	1	1	2	2	2	2
CO2	2	2	2	2	1	2	3	2	2	3
CO3	2	1	2	1	1	2	3	2	2	3
CO4	1	3	1	2	1	3	2	2	2	3
CO5	2	2	1	2	1	3	3	3	2	3
CO6	2	3	2	3	1	3	3	2	2	3
AVERAGE	1.83	2	1.67	1.83	1	2.33	2.7	2.17	2	2.83

Suggested Reading:

1. **"Sampling: Design and Analysis"** by Sharon L. Lohr
2. **“A First Course in Probability" by Sheldon Ross**
3. **"Statistical Quality Control: A Modern Introduction" by Douglas C. Montgomery**

Paper 3: Financial Analytics and Case Study Tools DSC: Discipline Specific Core (Course)

CO No.	Course Outcome (CO)
CO1	Understand the fundamentals of financial analytics, including its importance, types, components, and implementation strategies in addressing financial challenges.
CO2	Analyze and implement various types of financial analytics, such as fundamental and technical analysis, to solve real-world financial problems.
CO3	Explore the role of machine learning in financial analytics, including its applications in finance, process automation, risk management, and security.
CO4	Apply statistical and machine learning techniques, such as regression, correlation, and time series analysis, to solve financial problems and optimize financial models.
CO5	Analyze and interpret financial data using advanced techniques like cluster analysis, descriptive and inferential statistics, and apply them to financial decision-making.
CO6	Evaluate and implement financial analytics for various financial aspects, including sales, revenue, and profitability, cash flow, and risk analytics, with a focus on credit and market risk.

COURSE STRUCTURE:

Unit	Topic	Subtopic	Hours
Unit 1	Financial Analytics	1.1 Introduction to Financial Analytics	15
		1.2 Importance of Financial Analytics	
		1.3 Types of Financial Analytics	
		1.4 Fundamental Analysis and Technical Analysis	
		1.5 Components of Financial Analytics	
		1.6 Feature of Financial Analytics	
		1.7 Implementation of Financial Analytics	
		1.8 Financial Analytics and Current Financial Challenges	
		1.9 Fraud Risk and Profitability Portfolio	

		Management	
		1.10 Financial Analytics and current financial challenges	
Unit 2	Machine Learning	2.1 Adoption of Machine Learning in Financial Analytics	15
		2.2 Importance of Machine Learning n Financial Analytics	
		2.3 Market Data and Business Data	
		2.4 Financial Analytics and Process automation, Risk and Security	
		2.5 Application of Machine Learning in Finance	
Unit 3	Machine Learning in Financial Analytics	3.1 Machine Learning Techniques and their application in various financial Aspects	15
		3.2 Descriptive statistics 3.3 Inferential Statistics	
		3.3 Linear Regression	
		3.4 Multiple Linear Regression	
		3.5 Correlation	
		3.6 Cluster Analysis	
		3.7 Time series Analysis	
		3.8 Machine Learning Techniques and their application in various financial Aspects	
Unit 4	Financial Models	4.1 Sales and Revenue Analytics	15
		4.2 Profitability Analytics	
		4.3 Cash Flow Analytics	
		4.4 Risk Analytics	
		4.5 Credit Risk and Market Risk Analytics	
		4.6 Trading sentimental Analysis	
		4.7 Credit Rating and Customer Attrition Analysis, GARCH Models	

BLOOM'S TAXONOMY:

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	2	1	1	1	2	2	2	2
CO2	2	2	2	2	1	2	3	2	2	3
CO3	2	1	2	1	1	2	3	2	2	3
CO4	1	3	1	2	1	3	2	2	2	3
CO5	3	1	1	2	1	3	3	3	2	3
CO6	2	3	2	3	1	3	3	2	2	3
AVERAGE	2	1.83	1.67	1.83	1	2.33	2.7	2.17	2	2.83

Suggested Reading:

1. **"Financial Analytics with R: Building a Laptop Laboratory for Data Science" by Mark J. K. Kritzman and Richard H. L. Ament “A First Course in Probability" by Sheldon Ross**
2. **"Advances in Financial Machine Learning" by Marcos López de Prado**
3. **"Statistics and Data Analysis for Financial Engineering" by David Ruppert**