Curriculum

for

Bachelor of Science (BSc) Honors *in* Statistics and Data Science

Sessions: 2023-24, 2024-25, 2025-26, 2026-27

Department of Statistics and Data Science
Jahangirnagar University

INTRODUCTION

The Department of Statistics and Data Science (SDS) at Jahangirnagar University is committed to fostering statistical methods in its theoretical, applied, and in scientific research in alignment with the rapidly growing field of data science.

It is one of the four departments with which Jahangirnagar University started its journey in 1970. Initially, it was named as the "Department of Information Science", and it had changed to the "Department of Statistics" later on. In today's age of information, the adoption of new statistical methods and tools has grown enormously. The field of statistics is continuously evolving in response to the remarkable increase in demand for statistical thinking and methodology in scientific research. Keeping this in mind, the department is renamed in 2023 as "Department of Statistics and Data Science".

The department offers BSc (Honors), MS, MPhil, and PhD degrees in Statistics and Data Science. It also offers Master of Professional Studies (MPS) in Applied Statistics and Data Science (ASDS) under weekend program. Our regular programs cover a broad range of courses focusing theory, applications, and computation using different statistical software such as Python, R, SPSS, STATA, etc. In addition, research in the department focuses on advanced data science tools and covers several areas such as Data Mining, Machine Learning, Computer Intensive Statistics, Big Data, Spatial Data Analysis, Data Analytics, Meta-analysis, Biostatistics, Bioinformatics, Epidemiology, Demography, Design of Experiment, Time Series Modelling, Econometrics, Advance Statistical Modelling, etc.

The faculty members are well-experienced and well-known in their own field of research at home and abroad. In terms of number of students, faculty members, and facilities available in the department, it is now one of the best departments in the country.

It regularly updates its courses, which opens the window of opportunity for our students to get acquainted with the recent developments in the field and become able to implement the knowledge in their professional lives. We are very proud of our long track record of producing graduates who have become leaders in many areas of scientific and human endeavor. Many of them are working in diversified organizations both at home and abroad with a reputation. The percentage of graduates and their performance in different sectors, especially in the Teaching, Research, Financial Service, and Public Service sectors, are splendid. Some of the former students of the department are working in top-ranked universities around the globe.

It has been publishing a journal entitled “Journal of Statistical Studies” since 1982. The department moves forward with a good pace in order to encompass the state-of-art of development in statistics and data science globally. The department is well-equipped with computer facilities (with two big computer labs) for the students. The department has a seminar library with approximately 7,500 books and journals in total.

In addition to its core academic program, the department organizes lectures, seminars, and workshops throughout the year. Sports, cultural, and other co-curricular activities are well-organized, which portray national pride, prejudice, and heritage. Students are also supported with different scholarships available in the department.

Part A

1. **Title of the Academic Program:** BSc (Honors) in Statistics and Data Science
2. **Name of the University:** Jahangirnagar University
3. **Vision of the University:** Promoting and advancing world-class higher education in the University.
4. **Mission of the University:**
   - **Mission 1:** Creating skilled and trained human resources by providing technology-based education, fostering communication with the outside world, and expanding national and international collaboration and research activities.
   - **Mission 2:** Contributing effectively to the enhancing higher education standards in Bangladesh in alignment with international benchmarks.
   - **Mission 3:** Ensuring quality advanced higher education for all classes of citizens irrespective of religion, caste, creed, and gender.
5. **Name of the Program Offering Entity:** Department of Statistics and Data Science.
6. **VISION of the Department of Statistics and Data Science**

Establish the department as a center for excellence in Statistics and data science through evidence-based education, scientific research, and IT-based practice to address emerging global challenges.

7. **MISSION of the Department of Statistics and Data Science**

M1	Provide in-depth knowledge on statistical theories and data science techniques to the students so that they add value to the existing knowledge of Statistics and Data Science.
M2	Promote creative and critical thinking among students, enabling them to develop statistical theories and data science techniques and apply them in their professional lives.
M3	Deliver through a high-quality teaching-learning process the richness of multidisciplinary knowledge and skills so that the students can be prepared with modern techniques to serve the needs of the country.

8. Objectives of the Department of Statistics and Data Science

1. To equip students with cutting-edge knowledge of statistics and data science to develop their skills, particularly with computer intensiveness.
2. To foster specializing in advanced statistical and data science techniques to apply in scientific research aspects of the modern age and improve their employability in national and worldwide job markets.
3. To enhance leadership skills in the domains of statistics and data science, integrating analytical ability with ethics, collaboration, and communication, aiming to provide value-added insights on a global scale.

9. Name of the Degree: BSc (Honors) in Statistics and Data Science

10. Description of the Program:

Total duration of the program is 4 academic years, and the program comprises 8 semesters. In each academic year there are 2 semesters, and the duration of each semester is 6 months.

11. Graduate Attributes:

The attitudes of the graduates of the Department are aligned with the goals of outcome-based education, which intends to prepare its graduates not only with knowledge in Statistics and Data Science but also with the skills and attitudes necessary for success in various aspects of life. The following are the anticipated characteristics that graduates at the Department of Statistics and Data Science might cultivate under the outcome-based education framework:

- **Critical thinking and problem solving:** Graduates should develop the ability to analyze information critically and think independently to solve challenges with a logical and analytical mindset using different programming languages and statistical tools.
- **Effective communication skills:** Graduates should be capable of expressing ideas clearly, both in written and oral forms, and be able to communicate with diverse audiences through meaningful dialogue.

- **Teamwork, collaboration, and Timeliness:** Graduates are expected to collaboratively work in group settings, demonstrating the timely execution often demanded in professional environments.
- **Adaptability and lifelong learning:** Graduates should be open to acquiring new knowledge, skills, and attitudes throughout their careers to continuously update their competencies in response to evolving professional and societal demands.
- **Ethical and social responsibility:** Graduates are expected to demonstrate ethical decision-making, integrity, and a sense of responsibility towards their communities. They should understand the societal implications of their actions and contribute positively to the well-being of society.

12. Program Education Objectives (PEO)

PEO1	To impart comprehensive academic and practical literacy in statistics, data science, and related fields.
PEO2	To promote lateral thinking by way of enabling the students to come out with simple solutions for complex statistical and data science problems that supports critical analysis and decision-making process.
PEO3	To facilitate modern tools and techniques used in statistics and data science required for conducting scientific research and preparing them for employment.
PEO4	To foster innovative thinking for understanding not only how to apply certain methods, but when and why they are appropriate.
PEO5	To incorporate ethics and develop leadership skills, teamwork with effective communication and time management so that they add value at the global arena.

13. Program Learning Outcome (PLO)

PLO1	Students will learn the fundamentals of statistics and data science with applications.
PLO2	Students will be equipped with probability theory and will perform statistical inference in several circumstances, interpreting the results in an applied context.
PLO3	Students will create different quantitative and qualitative models to solve real-world problems in appropriate contexts.
PLO4	Students will apply statistical software packages, languages, and algorithms to process and analyze data appropriately.
PLO5	Students will design, carry out, and disseminate original research at the leading edge of the statistics and data science discipline.

14. Mapping MISSION with PEOs

PEOs	Mission 1	Mission 2	Mission 3
PEO1	**3**	**3**	**1**
PEO2	**2**	**3**	**3**
PEO3	**2**	**3**	**3**
PEO4	**2**	**3**	**2**
PEO5	**1**	**2**	**3**

Degree of strength: 3 – High; 2 – Medium; 1 – Low

15. Mapping PLOs with PEOs

PLO/PEO	PEO1	PEO2	PEO3	PEO4	PEO5
PLO1	**3**	**3**	**3**	**2**	**1**
PLO2	**3**	**2**	**3**	**3**	**1**
PLO3	**3**	**2**	**3**	**3**	**2**
PLO4	**2**	**2**	**3**	**3**	**3**
PLO5	**1**	**3**	**3**	**3**	**3**

Degree of strength: 3 – High; 2 – Medium; 1 – Low

Formulation of Course Code:

Each course contains a 4-digit subject code followed by 4-digit course code.

- The subject code is taken from the 'International Standard Classification of Education' published by UNESCO Institute for Statistics. In the document, the subject code for Statistics is 0542, for Mathematics is 0541, for ICT courses is 0610, for Economics is 0311, for Health-related courses is 0988, for Finance, Banking, and Insurance is 0412, for English is 0231, for Environment is 0521, etc.

- Following the subject code, each course contains a 4-digit course code. The first digit represents the year, the second digit is used for the semester number, and the last two digits represent the course serial number.

  Example: The course code **0542-1203** represents the 3rd Statistical and Data Science course of Semester 2 of Year 1.

Part B

1. **Structure of the Curriculum**

   a. **Duration:** Years: 4 Semesters: 8

   b. **Admission requirement:** Based on JU Admission Ordinance.

   c. **Credit requirement:** **146 credits**.

   d. **Total class-weeks in a semester:** 14 weeks.

   e. **Minimum CGPA requirements for graduation:**
   - For Bachelor (Honors) Degree – CGPA 2.25 on a scale of 4.
   - For Bachelor (Pass) Degree – CGPA 2.00 on a scale of 4.

   f. **Maximum academic years of completion:** 6 consecutive years.

   g. **Category of Courses:**

Sl. #	Course category	Description	Type	Number of courses	Total credits
1	General Education (GED) courses	Include interdisciplinary courses, beyond Statistics and Data Science, which provide a well-rounded learning experience for the students	Theory	10	10×3 = 30
			LAB	02	02×1 = 02
2	Core courses	Include courses that characterize the discipline	Theory	17	17×3 = 51
			LAB	14	11×1 = 11 03×2 = 06
3	Elective courses	Include courses for specialization within Statistics and Data Science	Theory	10	10×3 = 30
			LAB	09	09×1 = 09
4	Capstone course	Project Work to be conducted in the 8th semester	-	01	01×3 = 03
5	Viva voce	An oral examination to be conducted at the end of each year	-	04	04×1 = 04
Total Credit			**-**	**-**	**146**

h. **Year and Semester-wise Distribution of Courses:**

1st Year Semester 1:

Course Code	Course Title	Course Type	Credit
0542-1101	Introduction to Statistics and Data Science	CORE	3
0542-1102	Elements of Probability	CORE	3
0541-1103	Linear Algebra	MAT	3
0231-1104	English for Communication and Scientific Writing	GED	3
0311-1105	Mathematical Economics	GED	3
0610-1106	LAB - Statistical Analysis using MS Excel	LAB	1
0541-1107	LAB - Linear Algebra and Applications	LAB	1
Total credit			**17**

1st Year Semester 2:

Course Code	Course Title	Course Type	Credit
0542-1201	Probability Distributions	CORE	3
0541-1202	Calculus for Statistics and Data Science	MAT	3
0542-1203	Sampling Distributions	CORE	3
0541-1204	Numerical Analysis and Optimization	MAT	3
0314-1205	Demography	CORE	3
0610-1206	LAB – Programming and Data Analysis using Python	LAB	2
0610-1207	LAB - Numerical Analysis using Python	LAB	1
0542-1200	Viva-Voce	VIVA	1
Total credit			**19**

2nd Year Semester 1:

Course Code	Course Title	Course Type	Credit
0542-2101	Survey Methods	CORE	3
0542-2102	Statistical Inference	CORE	3
0541-2103	Mathematical Analysis and Differential Equations	MAT	3
0610-2104	Database Management System	CORE	3
0542-2105	Research Methodology	CORE	3
0542-2106	LAB - Application of Statistical Inference	LAB	1
0610-2107	LAB - Database Management and Applications	LAB	1
Total credit			**17**

2nd Year Semester 2:

Course Code	Course Title	Course Type	Credit
0542-2201	Advanced Survey Methods	Elective	3
0542-2202	Linear Regression Models	CORE	3
0542-2203	Stochastic Processes	Elective	3
0542-2204	Industrial Statistics	CORE	3
0610-2205	LAB – Programming and Data Analysis Using R	LAB	2
0542-2206	LAB - Field Work on Survey Methods	LAB	1
0542-2207	LAB - Applications of Linear Regression Models	LAB	1
0610-2208	LAB - Industrial Statistics and Optimization using Python	LAB	1
0542-2200	Viva-Voce	VIVA	1
Total credit			**18**

3rd Year Semester 1:

Course Code	Course Title	Course Type	Credit
0542-3101	Advanced Statistical Inference	Elective	3
0542-3102	Econometrics	CORE	3
0610-3103	Data Structures and Visualization	CORE	3
0412-3104	Financial Management & Actuarial Statistics	GED	3
0521-3105	Environmental Statistics	GED	3
0542-3106	LAB - Inference and Decision Making	LAB	1
0542-3107	LAB - Econometric Analysis	LAB	1
0610-3108	LAB - Data Structure and Visualization using Python and R	LAB	1
Total credit			**18**

3rd Year Semester 2:

Course Code	Course Title	Course Type	Credit
0542-3201	Non-linear and Flexible Regression Models	Elective	3
0542-3202	Statistical Simulation and Modelling	CORE	3
0610-3203	Data Mining	Elective	3
0542-3204	Biostatistics and Survival Analysis	CORE	3
0610-3205	LAB - Data Processing using SPSS and STATA	LAB	2
0542-3206	LAB - Application of Flexible Regression Models	LAB	1
0610-3207	LAB - Simulation using Python and R	LAB	1
0610-3208	LAB - Application of Data Mining Techniques	LAB	1
0542-3209	LAB - Analysis of Time to Event Data	LAB	1
0542-3200	Viva-Voce	VIVA	1
Total credit			**19**

4th Year Semester 1:

Course Code	Course Title	Course Type	Credit
0542-4101	Bayesian Inference	Elective	3
0610-4102	Machine Learning	Elective	3
0542-4103	Design and Analysis of Experiments	CORE	3
0912-4104	Epidemiology	GED	3
0542-4105	Order Statistics and Non-Parametric Approaches	Elective	3
0542-4106	LAB - Bayesian Inference and Decision Making	LAB	1
0610-4107	LAB - Application of Machine Learning Techniques	LAB	1
0542-4108	LAB - Design of Experiments and Applications	LAB	1
0542-4109	LAB - Applications of Non-Parametric Approaches	LAB	1
Total credit			**19**

4th Year Semester 2:

Course Code	Course Title	Course Type	Credit
0542-4201	Multivariate Analysis	Elective	3
0542-4202	Categorical Data Analysis	Elective	3
0542-4203	Time Series Analysis and Forecasting	CORE	3
0988-4204	Health Informatics	GED	3
0542-4205	LAB - Application of Multivariate Models	LAB	1
0542-4206	LAB - Application of Categorical Data Analysis Models	LAB	1
0542-4207	LAB - Time Series Analysis and Applications	LAB	1
0542-4208	Project Work	Capstone	3
0542-4200	Viva-Voce	VIVA	1
Total credit			**19**

Part C

Description of Courses

Year 1, Semester 1:

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-1101	Introduction to Statistics and Data Science	Core	3.0	100

1. Rationale of the Course:

The field of statistics is the science of learning from data. Statistics is a correct process behind how we make decisions and predictions based on data. Given the growing importance of decision-making and opinion based on data, it is crucial to gather clear knowledge about the organization, summarization, and analytical tools to transform data to the knowledge of the problems to make correct decisions.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of Statistics and Data Science and its applications. The specific objectives include:

- To understand fundamental concepts in Statistics and Data Science.
- To develop Skills in Data Summarization and Visualization
- To know how to calculate different measures of central tendency, dispersion, and correlation analysis with clear interpretations.
- To learn exploratory data analysis (EDA) methods.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students can understand the technical terms of Statistics and Data Science.	3	2	2	1	2
2. Students will be able to apply appropriate techniques to organize, summarize, and visualize data with interpretation.	3	3	2	3	2
3. Students will be able to compute appropriate measures of central tendency, dispersion, and correlation analysis with interpretation.	2	3	3	2	2
4. Students can understand the shape of the data to adopt appropriate statistical analysis tools.	1	2	3	3	2
5. Students will be able to apply various measures of attributes in real-life problems.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Introduction to Statistics and Data Science:** Overview of Statistics and Data Science, Importance in various fields. Basic concepts of Population, Sample, Variable, Types of Data, Level of Measurement.	Classroom Lecture and Discussion	1
2	**Data Summarization and Organization:** Understanding the dataset, Raw Data. Organizing Data, Construction of Frequency tables, Concept of Relative Frequency and its uses.	Classroom Lecture and Discussion	1, 2
3-4	**Data Visualization:** Graphing Qualitative Data, Shapes of Histograms, Frequency Polygon, Ogive, Stem-and-Leaf Display, Dot Plots, Time series plot.	Classroom Lecture and Discussion	1,2
5-6	**Measures of Central Tendency:** Mean, Median, and Mode for both Ungrouped and Grouped Data and their Applications in Real-life Problems.	Classroom Lecture and Discussion	3
7	Weighted mean, Trimmed Mean, Quartile, Decile, and Percentile, Five-number summary, and Box-and-Whisker Plots.	Classroom Lecture and Discussion	3,4
8-9	**Measures of Dispersion:** Absolute and Relative Measures of Dispersion and their Applications in Real Life Problems.	Classroom Lecture and Discussion	3
10-11	**Moments and Shape Characteristics of Distribution:** Moments, Sheppard's Corrections for Grouping Error, Skewness and Kurtosis.	Classroom Lecture and Discussion	4,5
12	**Simple Correlation and Regression:** Simple Correlation, Methods of Finding Simple Correlation with application. Concept of Regression, Simple linear regression, and applications.	Classroom Lecture and Discussion	3, 5
13	**Association of Attributes:** Association of Attributes, Types of Association, Methods of Measures of Association, Contingency Table.	Classroom Lecture and Discussion	4, 5

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
14	**Data Science Tools and Techniques:** Introductory Concepts of Machine Learning, Big Data, Spark, Hadoop, Python, R and their uses in Data Science.	Classroom Lecture and Discussion	1, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Premm, S. Mann, (2020). Introductory Statistics, 10th Edition, John Wiley and Sons.
ii. Kotu, V. and Deshpande, B. (2019). Data Science Concepts and Practice, 2nd Edition, Elsevier.

Supplementary Readings:

i. Saltz, J. S., and Stanton, J. M. (2017). An introduction to data science. Sage Publications.
ii. Lind, A. D., Marchal, W. and Wathen, S. (2020). Statistical Techniques in Business and Economics, 18th Edition, McGraw Hill Inc.
iii. Devore, J. L. (2020). Probability and Statistics for Engineering and the Science, 9th Edition, Cengage Learning.
iv. Ou, G., Zhu, Z., Dong, B., and Weinan, E. (2023). Introduction to Data Science. World Scientific.
v. Shah, C. (2020). A hands-on introduction to data science. Cambridge University Press.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-1102	Elements of Probability	Core	3.0	100

1. Rationale of the Course:

Probability is an indispensable tool in many applications of Engineering, Mathematics, Natural Sciences, Computing, Finance, Insurance, Medical Sciences, and of course in Statistics. In the era of big data and artificial intelligence, probability is a fundamental concept in machine learning and data science. Understanding the concept of probability is crucial for interpreting statistical data, risk assessment, performing scientific research, making informed decisions, and drawing meaningful conclusions from data.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of probability theory and its applications. The specific objectives include:

- To understand the fundamental concept of probability.
- To explore conditional probability and independence.
- To be familiar with the random variables and their probability distributions.
- To demonstrate proficiency in the mathematical formulation of generating functions, inversion theorem and Laplace transformation.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to demonstrate a solid understanding of fundamental probability concepts	3	3	3	1	2
2. Students should be able to apply probability models to solve real-world problems	3	3	2	3	2
3. Students should be able to analyze and solve a variety of probability problems, including problems related to random variables, expected values, and variance	2	3	3	2	2
4. Students should be able to apply probability concepts in the context of statistics and data analysis	1	2	3	3	2

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Set Theory**: Set, Point of a set. Finite set, Infinite set, Universal set, and Empty set, Set Operations.	Classroom Lecture and Discussion	1
2	**Basic Concepts of Probability:** Concept of probability and Importance of probability. Experiment, Outcomes, Equally likely Outcomes, Favorable Outcomes, Mutually Exclusive, Exhaustive Outcomes. Event, Different types of Events. Sample space, Sample Points, Event space. Odds and Odds Ratio. Function, Set Function, Probability Function.	Classroom Lecture and Discussion	1, 2
3	**Elementary Theorems on Probability:** Approaches to Defining Probability, Elementary Theorems on Probability, Probability Space, Tree Diagram.	Classroom Lecture and Discussion	1, 2
4-5	**Conditional Probability & Independence:** Defining Conditional Probability, Elementary Theorems on Conditional Probability. Independence of Events. Theorems and Applications of Total Probability and Bayes Theorem.	Classroom Lecture and Discussion	1, 2
6-7	**Random Variable:** Concept of Random Variable, Types of Random Variables, Probability Mass Function, Probability Density Function, Cumulative Distribution Function and Graphical Presentation.	Classroom Lecture and Discussion	3
8	Joint, Marginal, and Conditional Distributions, Independence of Random Variables. Distribution of function of random variables.	Classroom Lecture and Discussion	3
9	**Expectation:** Meaning of Expectation, Expectation of a Function of a Random Variable. Finding Different Measures of Central Tendency.	Classroom Lecture and Discussion	3, 4
10	**Expectation & Different Measures of Dispersion:** Finding Different Measures of Dispersion. Variance of a Function of a Random Variable. Markov's inequality and Chebyshev's Inequality.	Classroom Lecture and Discussion	3, 4
11	**Expectation of Several Random Variables:** Expectation of Sums and Products of Random Variables. Variance, Covariance, and Correlation Coefficient of Joint Random Variables. Conditional Expectation and Variance.	Classroom Lecture and Discussion	3, 4

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
12-13	**Moment Generating Function & Characteristic Function:** Moments**,** Skewness and Kurtosis. Moment Generating Function, Characteristic Function with Properties and Applications. Inversion Theorem.	Classroom Lecture and Discussion	4
14	**Cumulant Generating Function & Probability Generating Function:** Cumulant Generating Function, Probability Generating Function and their Properties.	Classroom Lecture and Discussion	4

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Ross, S. (2022). A First Course in Probability, 10th Edition, Pearson Education Inc.

Supplementary Readings:

i. Roy, M. K. and Roy, D.C. (2022). Fundamentals of Probability & Probability Distributions, 4th Edition.
ii. Devore, J. L. (2020). Probability and Statistics for Engineering and the Science, 9th Edition, Cengage Learning.
iii. Hines, W. W., Montgomery, D. C., Goldsman, D. M. and Borror, C. M. (2008). Probability and Statistics in Engineering, 4th Edition, Wiley.
iv. Tomar, S., and Thakur, A., (2023), Probability and Statistics Essentials for Data Science and Machine Learning: 200+ examples and pictures, Kindle Edition.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0541-1103	Linear Algebra	MAT	3.0	100

1. Rationale of the Course:

For statisticians to grasp multivariate statistics, manipulate data matrices, and apply fundamental ideas like eigenvalues and eigenvectors—which are vital to regression, modeling, and statistical computing—they must take a course in linear algebra. It provides the mathematical foundation that makes a variety of statistical techniques easier to apply and interpret.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of Statistics and its applications. The specific objectives include:

- To describe the basic concepts of vector spaces, e.g., independence, basis, dimensions, orthogonally, etc.
- To explore various essential characteristics of matrices, e.g., rank, determinant, eigenvalues and eigenvectors, factorizations, etc.
- To illustrate special categories of matrices with their properties.
- To develop skills to analyze and solve a linear system of equations using various methods.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students can understand real vector spaces and subspaces and apply their properties.	3	2	2	1	1
2. Students will be capable to understand the fundamental concepts of matrix algebra with different properties of matrices.	3	3	2	3	1
3. Students can find eigenvalues and eigenvectors and use them in applications.	1	1	3	2	2
4. Students can compute linear transformation, kernel and range, and inverse linear transformations and find matrices of general linear transformations.	1	2	3	3	2
5. Students can apply the theoretical results of linear algebra in real-life problems.	1	3	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Vector:** Introduction to Vector (Geometric), Norm of Vector, Vector Arithmetic, Dot Product, Projection, Cross Product, Basis of Vector Space, Vector Linear Combination.	Classroom Lecture and Discussion	1
2	Euclidean N-Space, Cauchy-Schwarz Inequality, Linear Transformations from R^n to R^m, Reflection Operators, Projection Operators, Rotation Operators.	Classroom Lecture and Discussion	1,3
3	**Inner Product Space:** Inner Product, Angle and Orthogonality in Inner Product Space, Orthonormal Bases – Gram-Schmidt Process, QR-Decomposition.	Classroom Lecture and Discussion	1
4	**Matrix and Matrix Operations:** Definition of Matrix, Matrix Operations and their Properties, Different Types of Matrices: Square, Identity, Scalar, Diagonal, Null, Symmetric, Skew-Symmetric, Orthogonal, Unitary, Hermitian.	Classroom Lecture and Discussion	2, 4
5	Skew-Hermitian, Random, Variance-Covariance and Correlation, Product, Kronecker Products, Partition of Matrices, Matrix Products as Linear Combinations, Transpose of Matrix, Trace of Matrix.	Classroom Lecture and Discussion	1, 2
6	**Determinant:** Meaning, Properties of Determinant, Determinant by Cofactor Expansion, Minors, Cofactors, Adjoints, Combinatorial Approach to Determinant, Evaluating Determinant by Row Reduction.	Classroom Lecture and Discussion	2
7-9	**Rank and Inverse Matrix:** Rank and Elementary Transformations of Matrices, Related Theorems of Ranks, Diagonal Reduction of Matrix, Adjoint, Inverse, Generalized Inverse of Matrix, Properties of Inverse, Matrix Inequalities and Maximization, Canonical and Normal form of Matrix, Linear Function of Matrices, Integration of Matrices, Elementary Matrices.	Classroom Lecture and Discussion	1, 4
10-11	**Solution of System of Linear Equation:** Introduction to Systems of Linear Equations, Different Methods - Elementary Row Operations,	Classroom Lecture and Discussion	4

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
	Row-Echelon form, Reduced Row-Echelon form, Gaussian Elimination, Gauss-Jordan Elimination, Matrix Inversion, Cramer's Rule, Homogeneous and Non-Homogeneous Systems.		
12	**Eigenvalues and Eigenvectors:** Definition of Eigenvalues and Eigenvectors, Diagonalization, Orthogonal Diagonalization.	Classroom Lecture and Discussion	3, 4, 5
13-14	**Characteristic Value Problem and Quadratic form:** Spectral Decomposition, Cholesky decomposition, LU-Decomposition: Solving Linear System by Factorization, Quadratic Form.	Classroom Lecture and Discussion	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Anton, H., Rorres, C., and Kaul, A., (2019). Elementary linear algebra: applications version. 12th Edition, John Wiley & Sons.
ii. Lay, D., Lay, S., and McDonald, J., (2021), Linear Algebra and Its Applications, 6th Edition, Pearson.

Supplementary Readings:

i. Gentle, J. E. (2017). Matrix algebra: Theory, computations, and applications in statistics, 2nd Edition, Springer
ii. Banerjee, S., & Roy, A. (2014). Linear algebra and matrix analysis for statistics Chapman and Hall/CRC Press.
iii. Schott, J. R. (2016). Matrix analysis for statistics. John Wiley & Sons.
iv. Yoshida, R., (2021), Linear Algebra and Its Applications with R, Routledge
v. Seber, G. A. (2008). A matrix handbook for statisticians. John Wiley & Sons.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0231-1104	English for Communication and Scientific Writing	GED	3.0	100

1. Rationale of the Course:

English for Communication and Scientific Writing is a specialized course designed to help students improve their English language skills, with a particular focus on communication and scientific writing. The course aims to develop students as confident English language users in academic and professional contexts. With a view to enhancing learners' level of accuracy in language use, this course focuses on correct sentence construction through grammatical lessons, developing understanding of the organization of academic writing and the structures of genre specific writing items.

2. Course Objectives:

The objectives of this course include:

- To enhance Scientific and Technical Vocabulary
- To improve Written Communication Skills
- To master the Structure and Style of Scientific Writing
- To develop Effective Presentation and Communication Skills

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will be able to demonstrate proficiency in scientific and technical writing	3	3	2	1	3
2. Students will be able to communicate complex scientific concepts effectively	3	3	2	3	2
3. Students will be able to apply critical thinking and research skills	1	2	3	2	3
4. Students will be able to understand and use proper citations and references	1	2	3	3	3
5. Students will be able to collaborate effectively in scientific and technical teams	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Clauses:** Structure, function, variation, and expansion of clause, Noun in the clause (number, determiners), Pronoun in the clause (number, case, agreement, and reference), Verb in the clause (form, tense, voice, mood, subject-verb agreement), Modifiers in the clause (adjective, adverb, infinitive, participles)	Classroom Lecture and Discussion	1

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
2	**Advanced Grammar:** Transformation of sentences, WH Questions, Punctuation, parallel structure **Advanced Vocabulary:** Confusing Words - Synonyms, Antonyms, Homonyms	Classroom Lecture and Discussion	1,2
3-4	**Listening:** Listening monologue, phonemes, situational dialogues, conversations	Classroom Lecture and Group work	2,3
5-6	**Reading:** Fractions of various modern fictions written in easy language, short stories, unseen comprehensions	Classroom Lecture and Group work	2,3
7	**Inference and Impressions:** Making inference, understanding how impressions are created, examining impact of words, examining points of view and reaching a conclusion	Classroom Lecture and Group work	2,3
8	**Summarizing and Comparison:** Summarizing a text, understanding use of words and their effects, comparing the style of fiction and non-fiction texts.	Classroom Lecture and Group work	2,3
9	**Newspaper Reading and Prose:** Newspaper (general news, cultural news, sports news, domestic and international news, entertainment news, advertisement, employment notice, editorial and articles), Prose relating to history, geography, science and technology	Classroom Lecture and Group work	2,3
10	**Pronunciation:** Introduction to pronunciation, places and manners of articulation, phonetic symbols, the most common mistakes in pronunciation, etc.	Classroom Lecture and Group work	2,5
11	**Professional writing:** Memorandum – Different types of Letters and Applications, e.g., Job application - Cover letter - CV - Complaint letter - Letter of Apology, etc. - Report	Classroom Lecture and Group work	3, 4
12	**Academic writing:** Summarizing — Paraphrasing - Essay writing - Writing film reviews	Classroom Lecture and Group work	3,4
13	**Technical Writing:** Practicing writing skills, Introduction to writing tools (ChatGPT, Grammarly, plagiarism checker)	Classroom Lecture and Group work	1, 5
14	**Speaking:** Making requests, giving commands, inviting people, giving advice, giving suggestions, Agreeing and disagreeing, Asking questions, Giving opinion, Making comments, Presenting a paper, Addressing an audience, etc.	Classroom Lecture and Group work	2

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. P.C. Das (2022). Applied English Grammar & Composition, Edition 2021-2022.
ii. Devlin, J. (2013). How to Speak and Write Correctly, 2nd edition, McGraw-Hill.

Supplementary Readings:

i. Educational Testing Service (2020). The Official Guide to the TOEFL iBT test, 6th edition.
ii. Raymond Murphy (2019). English Grammar in Use, 5th edition, Cambridge.

Course Code:	Course Title:	Course Type:	Credit Value: 3.0	Total Marks:
0311-1105	Mathematical Economics	GED		100

1. Rationale of the Course:

Economics is the study of how individuals, groups, and nations manage and use resources. This course is designed not only to gain the skills needed for understanding complex economic indicators but also to gain strong analytical and problems solving skills.

2. Course Objectives:

Here are the specific objectives of this course:

- To understand and predict economic trends using historical data for statistical forecasting in data science.
- To learn optimization techniques for resource allocation and decision-making in economic scenarios.
- To grasp causal inference methods for identifying relationships between economic variables in statistical analyses.
- To acquire skills in modeling and analyzing uncertainty, enhancing prediction and decision-making in data science.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will be able to develop knowledge of fundamental questions in economics	3	3	2	1	1
2. Students will be able to explain the main characteristics of model and theory formation in economics	2	3	2	1	1
3. Students will be prepared to apply microeconomic models to explain the functioning of a market economy, verbally and graphically	1	2	3	2	3
4. Students will be able to have a knowledge of and understand the basic concepts of macro theory and being able to provide a survey of the main characteristics of economic policy	1	2	3	3	3
5. Students will be able to apply basic economic theory to current economic issues	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Introduction:** Meaning of Economics, Microeconomics, Macroeconomics and Development Economics, Production Possibility Frontier, Opportunity Cost, Economic Growth Unemployment and Understanding Economic Data.	Classroom Lecture and Discussion	1
2-3	**Economic view of Demand, Supply and Price:** Concept of Demand and Supply, Law and determinants of Demand and Supply, Equilibrium in Demand and Supply, Shifting of Demand Supply curve and market equilibrium.	Classroom Lecture and Discussion	1, 2
4-5	**Utility:** Consumption Choices: Consumption Possibilities, Preferences, Budget Line, Meaning of Utility, Total Utility, Marginal Utility, Law of Diminishing Marginal Utility, Consumer Equilibrium, Utility Maximizing Rule, Paradox of Value.	Classroom Lecture and Discussion	2
6-7	**Economics of Production, Cost, and Revenue:** Factors of Production, Production Function. Total, marginal, average Product. Returns to Scale. Short Run and Long Run cost, Fixed and Variable Cost, Total, marginal, and average cost. Total, marginal, and average Revenue.	Classroom Lecture and Discussion	2
8	**GDP, GNP, and GNI:** Concept of GDP, GNP, and GNI. Approaches to compute GDP, GNP, and GNI. Use of Per Capita GDP, GNP, and GNI.	Classroom Lecture and Discussion	3, 4
9	**Index Number and Human Development Index (HDI):** Basic Concepts, Problem of Index Number, Different Types of Indexes, Errors in Index Number, Different Formulae, Tests of Index Numbers, Cost of Living Index, Consumer Price Index (CPI).	Classroom Lecture and Discussion	4
10	**Inflation and Deflation:** Causes of Inflation, Cost Push and Demand-Pull Inflation, Stagflation, Demand and Supply Side Factors of Inflation. Causes and Corresponding Types of Deflation, Computation of Inflation and Deflation, Effect of Inflation and Deflation on Different Economic Aspects.	Classroom Lecture and Discussion	3, 4
11	**Monetary and Fiscal Policy:** Types and Functions of Money, Instrument of Fiscal Policy, Budget, Sources of Revenue. Determination of Interest Rate, Exchange Rate Determination, Purchasing Power Parity (PPP) Multipliers.	Classroom Lecture and Discussion	4
12	**Income Distribution:** Law of Income and Wealth Distribution, Two Popular Income Distributions: Pareto Distribution and Lognormal Distribution.	Classroom Lecture and Discussion	4

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
13	**Measures of Living Standard and Poverty:** Different Approaches to Measure Living Standard: Income, Expenditure, and Consumption. Threshold Analysis. The Meaning and Measurement of Poverty: Cost of Basic Need (CBN), Poverty Gaps, Measurement and Determinants of Food Poverty. Multidimensional Poverty Index and Human Poverty Index.	Classroom Lecture and Discussion	4, 5
14	**Measurement of Inequality:** Meaning of Income Inequality, Graphical Representation of Inequality (Concentration Curve, Lorenz Curve). Inequality Indices (Gini Index, Hoover Index, Kakwani Index, etc.)	Classroom Lecture and Discussion	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Mankiw, N. G. (2022). Principles of Macroeconomics, 11th Edition, Cengage Learning.
ii. Parkin, M. (2018). Microeconomics, 13th Edition, Pearson Education Inc., Australia.

Supplementary Readings:

i. Cowen, T., and Tabarrok, A. (2021). Modern Principles: Microeconomics, 5th Edition, Worth Publisher.
ii. Case, K. E., and Fair, R. C. (2017). Principles of Microeconomics, 12th Edition, Pearson Education.
iii. Parkin, M. (2022). Macroeconomics, 14th Edition, Pearson.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-1106	LAB - Statistical Analysis using MS Excel	LAB	1.0	100

1. Rationale of the Course:

This course is designed to provide a practical, hands-on approach to understanding and applying statistical analysis techniques. This course emphasizes the importance of data analysis in various fields, aiming to bridge the gap between theoretical statistical concepts and their real-world applications using a familiar software platform.

2. Course Objectives:

The major objectives of this course include:

- To gain proficiency in using MS Excel for organizing, analyzing, and visualizing data.
- To understand key statistical concepts and apply them in practical data analysis scenarios.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to use Microsoft excel, to conduct basic statistical analysis.	1	2	2	3	3
2. Students should be able to apply basic statistical analysis techniques to real-world problems	1	3	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course '0542-1101: Introduction to Statistics and Data Science'.	Lab Exercises, Computer intensive learning, Interactive Workshops, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1,2

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer-intensive learning, Interactive Workshops, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests, and performance, Presentations, and Semester end examination.
CLO-2		

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0541-1107	LAB - Linear Algebra and Applications	LAB	1.0	100

1. Rationale of the Course:

This course is designed to merge the theoretical aspects of linear algebra with practical implementation using MS Excel. It emphasizes the importance of linear algebra in various computational fields for implementing the concepts in real-world scenarios.

2. **Course Objectives:**

The major objectives of this course include:

- To gain proficiency in performing basic operations in linear algebra.
- To enhance problem-solving skills by applying linear algebra concepts to real-world problems and applications.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to acquire proficiency in performing basic operations of linear algebra in MS Excel.	1	3	2	3	3
2. Students should be able to apply linear algebra concepts and techniques to solve real-world problems in MS Excel.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-1102: Linear Algebra".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1,2

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		

6. Assessment and Evaluation

As per the process outlined in Part D.

Year 1, Semester 2:

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-1201	Probability Distributions	CORE	3.0	100

1. Rationale of the Course:

Probability theory is the branch of mathematics that deals with modeling uncertainty. This course deals with the basics of probability distributions (both discrete and continuous). This course is important because of it's practical applications, preparing them for more advanced coursework in statistics, data science, and related fields.

2. Course Objectives:

This course is designed to provide an in-depth understanding of probability distribution among students. The specific objectives include:

- To learn the characteristics and parameters of various univariate discrete and continuous probability distributions.
- To understand and calculate probabilities, means, and variances for different probability distributions.
- To learn how the distribution of sample means approximates a normal distribution as sample sizes increase.
- To understand the application of probability distributions in making statistical inferences and predictions.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will gain a comprehensive understanding of the characteristics and parameters of various univariate discrete and continuous probability distributions.	3	2	1	1	2
2. Students will learn to accurately compute probabilities, means, variances, and other relevant statistical measures for different probability distributions.	3	3	2	1	2
3. Students will learn how the distribution of sample means approaches a normal distribution for large sample sizes.	1	3	3	2	3
4. Students will be able to solve several practical problems with the help of discrete and continuous probability distributions.	1	2	3	3	2
5. Students will enhance their problem-solving skills by applying probability distributions to a variety of practical problems and scenarios.	1	2	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-2	**Univariate Discrete Distributions**: Bernoulli, Binomial, Geometric, Negative Binomial.	Classroom Lecture and Discussion	1, 2, 4, 5

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
3-4	Poisson, Rectangular, Hypergeometric.		1, 2, 4, 5
5-6	Multinomial, Logarithmic, Beta-Binomial, Truncated Distributions.	Classroom Lecture and Discussion	1, 2, 4, 5
7-8	**Univariate Continuous Distributions:** Normal Distributions: Normal, Log-Normal and Half Normal.	Classroom Lecture and Discussion	1, 2, 3, 5
9-10	Uniform, Exponential, Gamma, Beta, Cauchy.	Classroom Lecture and Discussion	1, 2, 4, 5
11	Weibull, Erlang, Rayleigh Distributions, Pareto Distribution.	Classroom Lecture and Discussion	1, 2, 4, 5
12	**Inverted Distributions:** Inverted Exponential, Inverted Gamma, Inverse Gaussian.	Classroom Lecture and Discussion	1, 2, 4, 5
13	**Exponential Family of Distribution:** Mean, Variance, Link Function.	Classroom Lecture and Discussion	1, 2, 4, 5
14	**Bivariate Distribution**: Binomial, Poisson, Normal.	Classroom Lecture and Discussion	1, 3, 4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Krishnamoorthy, K. (2020). Handbook of Statistical Distributions with Applications, 2nd Edition, Chapman and Hall/CRC.

Supplementary Readings:

i. Johnson, N. L., Kemp, A. W., & Kotz, S. (2005). Univariate discrete distributions. John Wiley & Sons.
ii. Johnson, N. and Balakrishnan, N. (1995). Continuous Univariate Distribution, 2nd Edition, John Wiley and Sons, New York.
iii. Devore, J. L. (2016). Probability and Statistics for Engineering and the Science, 9th Edition, Cengage Learning.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0541-1202	Calculus for Statistics and Data Science	MAT	3.0	100

1. Rationale of the Course:

Statistics is applied mathematics. It is difficult to understand statistics without sound knowledge of mathematics, especially knowledge of algebra, calculus, and geometry. This course is designed to demonstrate the students to different mathematical concepts an algebra calculus and geometry.

2. Course Objectives:

The objectives of this course include:

- To develop an understanding of algebraic representation and its applications in statistics and data science.
- To gain proficiency in recognizing, classifying, and utilizing real numbers in statistical contexts.
- To achieve a deep comprehension of differential and integral calculus, along with analytical geometry, for data analysis.
- To foster logical and abstract thinking skills through calculus concepts relevant to statistics and data science.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will develop a solid understanding of algebraic concepts and their application in data science and statistical analysis.	3	2	2	1	2
2. Students will gain the ability to recognize, classify, and effectively use real numbers within the context of statistical data.	3	3	2	3	2
3. Students will develop a comprehensive understanding of differential and integral calculus and analytical geometry for practical application in data science.	2	3	3	2	2
4. Students will cultivate skills in logical reasoning and abstract thinking through the study of calculus, enhancing problem-solving in statistics and data science.	1	2	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-2	**Functions**: Relation, Functions, Domain, Range, Graphs of Functions Like Exponential, Logarithmic, Trigonometric and Inverse Function, Polynomial Function, rational function etc.	Classroom Lecture and Discussion	1

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
3	**Limits and Continuity**: Intermediate form, Tangents, and Normal. Asymptotes of Graphs, Sandwich Theorem.	Classroom Lecture and Discussion	1, 4
4-5	**Differentiation**: Differentiability, Derivative Techniques, Shapes and Application of Different Differentiation, Asymptotes, Higher Derivatives.	Classroom Lecture and Discussion	3
6	Chain Rule Implicit Differentiation, Leibnitz Theorem, Partial Derivatives; Euler's Theorem.	Classroom Lecture and Discussion	3
7-8	**Applications of Derivatives:** L-Hospital's Rule, Rolle's Theorem, Mean Value Theorem, Residue Theorem, Maxima and Minima, Extrema; Curve Sketching (Graphs)	Classroom Lecture and Discussion	2, 3
9-10	Algebraic Clues-Symmetry Criteria, Intercepts, First Derivative-Maxima, Asymptotes, Minima, Second Derivative-Concavity, Points of Inflection.	Classroom Lecture and Discussion	3
11-12	**Integration:** Integral Techniques, Method of Substitution, Integration by Parts, Application of Integration; Definite Integral as Limit of Sum, Interpretation as Area, Fundamental Theorem of Integral Calculus.	Classroom Lecture and Discussion	3, 4
13-14	**Applications and Techniques of Integration:** Determination of Length and Area, Reduction Formulae, Multiple Integrals Like Double Integral, Triple Integral, etc., Jacobian, Taylor's Theorem, Maclaurin's Theorem, Beta and Gamma Functions, Improper Integrals.	Classroom Lecture and Discussion	3, 4

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Anton, H. (1995). Calculus with Analytic Geometry, 5th Edition, Wiley, New York.
ii. Weir, P. B. M. D., Hass, J., Heil, C., (2024). Thomas' Calculus, 15th Edition, Pearson.

Supplementary Readings:

i. Apostol, T. M. (1967 and 1969). Calculus, Vol. I and II, 2nd Edition, John Wiley and Sons, New York.
ii. Van Der Post, H., Bisette, V., Schwartz, A. (2024). Calculus for Data Science: A comprehensive Survey to the Application of Calculus to Data science in 2024. Independently published.
iii. Ayres, F. and Meldelson, E. (2013). Schaum's Outlines Calculus, 6th Edition, Mcgraw-Hill, New York.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-1203	Sampling Distributions	Core	3.00	100

1. Rationale of the Course:

This course aims to deepen understanding of inferential statistics by focusing on the creation and analysis of sampling distributions. It bridges theoretical concepts with practical application, equipping students with essential skills for accurate population inferences from sample data, crucial in data science and statistical analysis.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of probability theory and its applications. The specific objectives include:

- To understand and demonstrate the distribution of functions and random variables in various contexts.
- To learn and illustrate the sampling distribution of different statistical measures.
- To grasp and explain the law of large numbers and the central limit theorem.
- To conduct hypothesis tests based on sample data and sampling distributions.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to demonstrate a solid understanding of fundamental Sampling Distribution concepts	3	2	2	1	2
2. Students should be able to apply the central limit theorem to calculate approximate probabilities for sample statistics	3	3	2	3	2
3. Students should be able to describe the sampling distribution of the sample statistics	1	2	3	2	2
4. Students should be able to identify situations in which different sampling distributions may be used	1	2	3	3	2

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Definition and Concept:** Definition of Parameter and Statistic. Concept and Importance of Sampling Distribution. Methods of Obtaining Sampling Distribution.	Classroom Lecture and Discussion	1
2	**Variate Transformations:** Cumulative Distribution Function Technique, Moment Generating Function Technique and Transformation Technique, Laplace Transformation.	Classroom Lecture and Discussion	1

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
3	**Law of Large Number:** Theory of Large Samples, Convergence of Random Variable, Modes of Convergence, Law of Large Number	Classroom Lecture and Discussion	2
4-5	**Central Limit Theorem:** Standard Errors of Estimators in Large Samples: Mean, Variance, Standard Deviation, Correlation Coefficient, Regression Coefficient, Coefficient of Variation.	Classroom Lecture and Discussion	2
6-8	**Central Sampling Distributions:** Distribution of Central Chi-Square, Student's t, and F Statistics.	Classroom Lecture	3, 4
9-10	**Non-Central Sampling Distributions:** Distribution of Non-Central Chi-Square, Student's t, and F Statistics.	Classroom Lecture	3, 4
11-12	**Exact Sampling Distributions and their Properties**: Exact Sampling Distributions Related to Normal Population. Distribution of Sample Mean, Sample Variance, Sample Covariance.	Classroom Lecture and Discussion	1, 3, 4
13-14	Distribution of Sample Correlation and Regression Coefficients, Joint Distribution of Sample Correlation Coefficient and Covariances, Fisher's Z Distribution, Asymptotic Statistics, Delta Method.	Classroom Lecture and Discussion	1, 3, 4

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Hogg, R. V., McKean, J. W., & Craig, A. T. (2020). Introduction to mathematical statistics. 8th Edition, Pearson.

Supplementary Readings:

i. Mood, A. M., Graybill, F. A. and Boes, D. C. (1974). Introduction to the Theory of Statistics, 3rd Edition, McGraw Hill, UK.
ii. Rohatgi, V. K., & Saleh, A. M. E. (2015). An introduction to probability and statistics. John Wiley & Sons.
iii. Vaart, A. W. V. D. (2000). Asymptotic Statistics, 2nd Edition, Cambridge University Press, UK.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0541-1204	Numerical Analysis and Optimization	MAT	3.0	100

1. Rationale of the Course:

Numerical Analysis and Optimization serve as fundamental pillars underpinning problem-solving in diverse fields. This course is designed to equip students with the essential tools and knowledge needed to tackle complex mathematical problems, make data-driven decisions, and optimize processes. These skills are invaluable across disciplines, providing a bridge between theory and practice, and enabling graduates to excel in fields ranging from engineering to finance.

2. Course Objectives:

- To understand and apply numerical techniques like root-finding, interpolation, and numerical integration for solving mathematical problems.
- To design, implement, and analyze optimization algorithms for linear and nonlinear problems, considering various constraints and objectives.
- To evaluate the accuracy, convergence behavior, and computational efficiency of numerical solutions and optimization results.
- To apply numerical analysis and optimization techniques in practical scenarios across diverse domains, bridging theory and practice.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will be able to apply numerical methods, assess accuracy, and make data-driven decisions.	3	2	2	1	2
2. Students will be able to design, implement, and analyze optimization algorithms for linear and nonlinear problems, and evaluate solutions.	3	3	2	3	2
3. Students should be able to analyze and compare numerical solutions and optimization outcomes.	2	3	3	2	2
4. Students will be able to apply numerical analysis and optimization in practical contexts, connecting theory with application.	3	3	3	3	3
5. Students will be able to use critical thinking to select appropriate methods, assess results, and make data-driven decisions.	3	3	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-2	**Roots of Equations:** Incremental Search Method, Method of Bisection, Methods Based on Linear Interpolation, Newton-Raphson Method, Systems of Equations.	Classroom Lecture and Discussion	1, 3, 5
3-5	**Polynomial Interpolation:** **Interpolation with equal intervals:** Newton's Method, Gauss's method, Stirling's method, Bessel's method**.**	Classroom Lecture and Discussion	1, 3, 5

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
6	**Interpolation with unequal intervals:** Newton's Method, Lagrange's Method, Limitations of Polynomial Interpolation, Inverse interpolation.	Classroom Lecture and Discussion	1, 3, 5
7	**Numerical Differentiation:** Finite Difference Approximations, Richardson Extrapolation, Derivatives by Interpolation.	Classroom Lecture and Discussion	1, 3, 5
8-9	**Numerical Integration:** Newton-Cotes Formulas, Gaussian Integration, Double integration Integrals.	Classroom Lecture	1, 3, 5
10	**Initial Value Problems:** Taylor Series**,** Euler's Method, Modified Euler's Method, Runge-Kutta Methods.	Classroom Lecture	1, 3, 5
11-12	**Basic Concepts of Numerical Optimization:** Formulating an Optimization Problem, Local and Global Optimality, Existence of an Optimal Solution.	Classroom Lecture and Discussion	2, 4, 5
13-14	Level Sets, Gradients, Convex Sets, Constrained and Unconstrained Optimization**.**	Classroom Lecture	2, 4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1 To CLO-5	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Burden, R.L., Faires, J. D., and Burden, A.M. (2015). Numerical Analysis, 10th Edition, Cengage Learning.
ii. Scarborough J. B. (1996). Numerical Mathematical Analysis, 6th Edition, Johns Hopkins University Press.
iii. Bertsimas, D., & Tsitsiklis, J. N. (1997). Introduction to Linear Optimization, 2nd Edition, Athena Scientific.

Supplementary Readings:

i. Nocedal, J., & Wright, S. J. (2006). Numerical Optimization, 2nd Edition, Springer.
ii. Gilat, A., & Subramaniam, V. (2008). Numerical Methods for Engineers and Scientists, 3rd Edition. Wiley.
iii. Miles, W. (2023). Numerical Methods with Python: For the Sciences. Walter de Gruyter GmbH & Co KG.
iv. Johansson, R. (2018). Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib, 2nd Edition, Apress, Berkeley, CA.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0314-1205	Demography	Core	3.00	100

1. Rationale of the Course:

This course is meticulously designed to provide an in-depth understanding of demographic principles and to apply various demographic methodologies for analyzing population characteristics. The field of demography addresses critical inquiries about population structure and dynamics, offering insights into how populations grow, change, and interact with various societal factors.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of Demography and its applications. The specific objectives include:

- To introduce students to the fundamental concepts of demography, including the study of populations and the nature of demographic data.
- To enhance students' abilities in analyzing key demographic phenomena such as fertility, reproduction, mortality, and morbidity.
- To guide students in constructing and analyzing different types of life tables, a crucial tool in demographic studies.
- To foster the development of critical thinking and analytical skills, enabling students to make meaningful contributions to demography and population research.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will be able to gain an understanding of key demographic concepts and population studies.	3	3	2	1	2
2. Students will develop skills in calculating and interpreting essential demographic measures.	3	3	2	3	2
3. Students will be able to enhance analytical abilities for examining fertility, mortality, and other demographic phenomena.	2	3	3	2	2
4. Students will be able to acquire the ability to construct and analyze life tables for population trend predictions	2	2	3	3	2
5. Students will be able to apply demographic knowledge to assess and address societal impacts of population trends.	2	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Introduction:** Demography and Population Studies. Important Characteristics of Demography. Use of Demographic Information in different Disciplines.	Classroom Lecture and Discussion	1
2	**Demographic Data:** Sources of Demographic Data, Methods of Demographic Data Collection, Assessment of Quality of Demographic Data, Concept of De Facto and De Jure Population, Characteristics of Adequate Population Census, Vital Registration Method, Sample Surveys and their Advantages and Disadvantages.	Classroom Lecture and Discussion	1, 2
3-4	**Errors in Demographic Data:** Sources of Type of Errors in Demographic Data and their Correlations, age Heaping, age Misstatement, Under Enumeration, Over Count etc., Application of Different Methods in Detecting Errors/Digital Preferences, Estimation Method of Under Count and Over Count.	Classroom Lecture and Discussion	2
5	**Age and Sex Composition:** Age and sex Composition and Structure, Age Heaping Evaluation of Age and Sex Data, Myer's Index, Population Pyramid, Cohort and Lexis Diagram.	Classroom Lecture and Discussion	2
6	**Demographic Rates and Ratios:** Concepts of rates, ratios, proportions and probability crude rates and refined rates**.**	Classroom Lecture and Discussion	2
7-8	**Fertility and Fecundity:** Detail Study of Fertility, Fecundity, Fecundity, Various Measures of Fertility, Important Determinants of Fertility, Estimation of Mean Age at Childbearing.	Classroom Lecture and Discussion	3, 4
9-10	**Standardization:** Concept of Standardization in Demographic Measurements, Role of Standardization, Different Methods of Standardization with their Merits and Demerits, Stable Population and its Properties, Lotke's and Derivation of Stable Population Model.	Classroom Lecture and Discussion	3, 4 ,5
11-12	**Mortality and Morbidity:** Concept of Mortality and Morbidity, Important Determinants of Mortality, Various Measures of Mortality and Morbidity, Adjusted Measures of Morbidity, IMR and its	Classroom Lecture and Discussion	3, 5

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
	Components (Neonatal and Post-Neonatal Infant Mortality).		
13-14	**Life Table:** Definition, use and functions of life tables different types of life table, construction of life table. Actuarial life table, its construction and applications. Force of mortality and related problems.	Classroom Lecture and Discussion	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Swanson, D. A. and Siegel, J. S. (2004). The methods and materials of Demography, 2nd Edition, Emerald Group Publishing.

Supplementary Readings:

i. Thomas, R.K., (2024). Demography: An Introduction to Population Studies. Springer.
ii. Keyfitz, N. (2005). Applied Mathematical Demography. 3rd Edition, John Wiley & Sons.
iii. Wachter, K. W. (2014). Essential demographic methods. Harvard University Press.
iv. Barclay, G. W. (1958). Techniques of Population Analysis, Wiley, New York.
v. Biswas, S. (1988). Stochastic Process in Demography and Applications, Wiley Eastern, New Delhi

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-1206	LAB – Programming and Data Analysis using Python	LAB	2.0	100

1. Rationale of the Course:

The course "Programming and Data Analysis using Python" for Statistics and Data Science is designed to equip students with a foundational understanding of programming concepts using Python. Students will gain the practical skills necessary for effective data manipulation, analysis, and visualization, essential for pursuing advanced studies and careers in statistics and data science.

2. Course Objectives:

The major objectives of this course include:

- To familiarize students with Python's syntax, data structures, and essential programming concepts for data manipulation.
- To develop students' skills in using Python for statistical data analysis, exploration, and visualization.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will demonstrate mastery in the fundamental aspects of Python programming, including understanding and applying Python syntax, data structures, and key programming concepts for effective data manipulation.	1	2	2	3	2
2. Students will develop proficiency in utilizing Python for statistical data analysis, including data exploration and visualization, enabling them to extract and interpret meaningful insights from datasets.	2	3	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-2	**Fundamentals of Python**: Installing Python, Anaconda, Spyder, Jupyter Notebook, Colab; Python Editors, Essential Python Libraries.	Computer intensive Lab	1
3-4	**Basic Python Programming:** the basic syntax of a Python program, Python data types; expressions	Computer intensive Lab	1

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
	and variables; lists, tuples, sets, and dictionaries; writing conditions, loops, and functions.		
5	**NumPy Basics - Arrays and Vectorized Computation:** The NumPy ndarray-A Multidimensional Array Object-Creating ndarrays and Data Types for ndarrays, Basic Indexing and Slicing, Universal Functions: Fast Element-wise Array Functions, Data Processing Using Arrays, File Input and Output with Arrays, Linear Algebra.	Computer intensive Lab	1
6-7	**Getting Started with pandas:** Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics, Handling Missing Data, Hierarchical Indexing, Other pandas Topics-Integer Indexing and Panel Data.	Computer intensive Lab	2
8-9	**Data Loading, Storage, and File Formats**: Reading and Writing Data in Text Format, Binary Data Formats, Interacting with HTML and Web APIs, Interacting with Databases-Storing and Loading Data in MongoDB.	Computer intensive Lab	2
10-11	**Data Wrangling- Clean, Transform, Merge, Reshape**: Combining and Merging Data Sets, Reshaping and Pivoting, Data Transformation, String Manipulation	Computer intensive Lab	2
12	**Plotting and Visualization:** A Brief matplotlib API Primer, Plotting Functions in pandas, Plotting Maps: Visualizing Haiti Earthquake Crisis Data, Python Visualization Tool Ecosystem	Computer intensive Lab	2
13	**Data Aggregation and Group Operations**: Group By Mechanics, Data Aggregation, Group-wise Operations and Transformations, Pivot Tables and Cross-Tabulation	Computer intensive Lab	2
14	**Time Series:** Date and Time Data Types and Tools, Time Series Basics, Date Ranges, Frequencies, and Shifting, Time Zone Handling, Periods and Period Arithmetic, Resampling and Frequency Conversion, Time Series Plotting, Moving Window Functions.	Computer intensive Lab	2

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings

i. McKinney W. (2022). Python for data analysis: Data wrangling with Pandas, NumPy, and Jupyter, 3rd edition. O'Reilly.
ii. Guttag, J.V. (2016). Introduction to computation and programming using Python. 2nd edition. MIT Press.

Supplementary Readings:

i. Ernesti, J. and Kaiser, P. (2022). Python 3: The Comprehensive Guide to Hands-On Python Programming. Rheinwerk Computing.
iii. Codeprowess, (2024). Python Programming for Beginners. Independently published.
iv. Taneja, S., Kumar, N. (2018). Python Programming- A modular Approach. Pearson Education India.

Course Code:	Course Title:	Course Type:	Credit Value: 1.0	Total Marks:
0610-1207	LAB - Numerical Analysis using Python	LAB		100

1. Rationale of the Course:

This course aims to enable students with a practical understanding of applying numerical methods to solve complex mathematical problems efficiently. By integrating Python's robust libraries, the course fosters a hands-on approach to implement algorithms for root finding, interpolation, differentiation, integration, and solving differential equations.

2. Course Objectives:

The major objectives of this course include:

- To introduce students to fundamental numerical methods and algorithms used for solving mathematical problems using the Python programming language.
- To enable students to gain practical experience in implementing and applying numerical techniques to solve real-world problems in engineering, physics, and other scientific disciplines.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be competent in analyzing and evaluating the accuracy and efficiency of different numerical techniques using Python.	2	2	2	3	2
2. Students should be able to develop and optimize Python code for numerical computations, utilizing Python's libraries and tools effectively.	2	3	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0541-1204: Numerical Analysis and Optimization".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1, 2

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		

6. Assessment and Evaluation

As per the process outlined in Part D.

Year 2, Semester 1:

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-2101	Survey Methods	CORE	3.0	100

1. Rationale of the Course:

This course is designed to provide students with an in-depth understanding of the principles and practices of survey research. It addresses the growing need for skilled survey researchers in various fields, including social sciences, market research, public opinion polling, and health studies. The course aims to cover the theoretical foundations of survey methodology, as well as practical aspects like survey design, sampling techniques, data collection, and analysis.

2. Course Objectives:

This course is designed to provide preliminary understanding about survey techniques and its utilization. The specific objectives include:

- To understand the theoretical underpinnings and practical applications of survey research.
- To develop skills in designing and implementing effective surveys.
- To master various sampling techniques and data collection methods for accurate survey results.
- To learn to analyze and interpret survey data effectively, focusing on accurate conclusions and insights.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will demonstrate a thorough understanding of the principles and applications of survey research, including its theoretical foundations.	3	2	2	1	2
2. Students will gain proficiency in designing, implementing, and managing surveys, ensuring effective question formulation and survey execution.	3	3	2	3	2
3. Students will acquire skills in applying appropriate sampling methods and data collection techniques, focusing on ensuring the accuracy and reliability of survey data.	2	3	3	2	2
4. Student will be able to estimate the convenient sample size for different method.	2	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Concept of Sampling and Sampling Approaches:** Meaning of Sampling, Importance of Sampling, Census and Survey, uses of Sample Survey, Principal Steps in Sample Survey, Advantages of Sampling, and Limitations of Sampling. Introduction to Probability and Non-probability Sampling; Equal and Varying Probability Sampling. Concept of Sample, Sampling Units, Sampling Frame. Methods of Drawing Random Sample.	Classroom Lecture and Discussion	1, 2
2-3	**Simple Random Sampling (SRS):** SRS with Replacement and Without Replacement. Advantages and disadvantages of SRS. Estimation of population characteristics using SRS, Determination of Sample Size in SRS.	Classroom Lecture and Discussion	3, 4
4-5	**Stratified Sampling:** Concept, Reasons for using Stratified Sampling, Steps involved in Stratified Sampling. Estimation of population characteristics in Stratified Sampling. Estimating sample size, Allocating sample size to strata. Relative Precision of Stratified Sampling. Advantages and Disadvantages.	Classroom Lecture and Discussion	3, 4
6-7	**Systematic Sampling:** Concept, Drawing Systematic Sample, Estimation of population characteristics using Systematic Sampling, Determination of Sample Size in Systematic Sampling. Precision of Systematic Sampling, Advantages and Disadvantages.	Classroom Lecture and Discussion	3, 4
8-9	**Cluster Sampling:** Concept, Reasons for using Cluster Sampling, Types of Cluster Sampling, Clustering Principles. Single-Stage Cluster Sampling with Equal and Unequal Sizes, Estimation of population characteristics, Determination of Sample Size, Design effect, Relative Efficiency of Cluster Sampling. Advantages and Disadvantages.	Classroom Lecture and Discussion	3, 4
10-11	**Multi-stage sampling:** Concept of Tow Stage Sampling, Estimating Means and Variances in Two-Stage Sampling. Multi-Stage Sampling. Concept of Sampling weights under different sampling schemes.	Classroom Lecture and Discussion	3, 4

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
12-13	**Sampling with Varying Probability:** Methods of Selecting PPS Sample, Estimation in PPSWR Sampling, Cumulative Total Method, Lahiri's Method, Sampling with PPSWOR, Desraj's Ordered Estimator, Inclusion Probabilities, Horvitz-Thompson Estimator, Sen-Midzuno Method, Random Group Method, Relative Efficiency of Different Ordered and Unordered Estimators.	Classroom Lecture and Discussion	3, 4
14	**Non-probability Sampling:** Convenience Sampling, Purposive Sampling, Judgment Sampling, Snowballs Sampling, Area Sampling.	Classroom Lecture and Discussion	3, 4

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Cochran, W. G. (2002). Sampling Techniques, 4th Edition, Wiley Eastern, New Delhi.
ii. Thompson, S. K. (2012). Sampling, 3rd Edition, John Wiley and Sons Inc., New York.

Supplementary Readings:

i. Lohr, S. L. (2010): Sampling. Design and Analysis, 2nd Edition, Brooks/Cole, Cengage Learning.
ii. Murthy, M. N. (1977). Sampling Methods, 2nd Edition, Statistical Publishing Society, Calcutta.
iii. Sampath, S., (2005). Sampling Theory and Methods. 2nd Edition, Alpha Science.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-2102	Statistical Inference	CORE	3.0	100

1. Rationale of the Course:

This course is designed to provide students with a comprehensive understanding of advanced statistical methods, focusing on techniques widely used in data analysis, research, and applied statistics. The course will enable students to develop a deep understanding of key statistical concepts and their applications in various real-world contexts. Students will be equipped with the skills necessary to analyze complex data sets and make informed decisions based on their analyses.

2. Course Objectives:

This course is designed to provide preliminary understanding for drawing inferential conclusion about some unknown aspect of a population based on a random sample. The specific objectives include:

- To introduce students to the fundamental concepts and methods of statistical inference, including maximum likelihood estimation and the method of moments.
- To develop students' ability to evaluate and apply various estimators in statistical analysis, focusing on their properties like bias, consistency, and efficiency.
- To enhance students' skills in hypothesis testing, including understanding and applying different types of test statistics and error types.
- To provide students with a thorough understanding of advanced statistical concepts such as sufficiency, efficiency, and interval estimation.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will be able to understand and apply maximum likelihood estimation and the method of moments in various statistical distributions.	3	3	2	1	2
2. Students will evaluate statistical estimators for bias, consistency, sufficiency, efficiency, mean square error, and interval estimation.	3	3	3	1	2
3. Students will be able to conduct hypothesis tests using Z, t, F, and chi-square tests, and understand Type I and II errors.	2	3	3	2	2
4. Students will apply statistical methods to real-world data and effectively interpret and communicate findings.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-2	**Maximum likelihood estimation:** random sample, statistic and estimator, method of point estimation and estimation theory: Maximum likelihood estimation, Fisher information matrix (parameter estimation for Binomial, Poisson, normal distribution, exponential, uniform, etc.), iterative procedures for calculation maximum likelihood estimations (using the Newton-Raphson method, Fisher's scoring method), (for example, Cauchy distribution), asymptotic properties of MLE estimators.	Classroom Lecture and Discussion	1
3	**Method of moments:** Method of moments e.g., parameter estimation for Binomial, Poisson, normal distribution, exponential, uniform, etc., least square estimation, asymptotic properties of estimators.	Classroom Lecture and Discussion	1
4-5	**Criteria of a good estimator:** unbiases, consistency, efficiency, sufficiency, mean square error, best-unbiased estimator, consistent asymptotically normal estimators, best asymptotically normal estimators,	Classroom Lecture and Discussion	2
6	**Efficiency**: minimum variance bound, minimum variance unbiased estimators, uniformly minimum variance unbiased estimators, Cramer-Rao lower bound, efficiency of regular Estimators.	Classroom Lecture and Discussion	2
7	**Sufficiency:** completeness, Rao-Blackwell theorem, Lehman-Scheffe theorem, ancillary statistics, minimal sufficient statistics, sufficiency of general order statistics.	Classroom Lecture and Discussion	2
8-9	**Interval estimation:** fundamental notions of confidence interval estimation, different methods of interval estimation (for mean, variance, proportion, etc.), properties and construction of confidence interval by different methods	Classroom Lecture and Discussion	2
10-11	**Test of hypothesis:** Hypothesis, types of hypotheses, Steps of test of hypothesis, Type I and Type II errors, level of significance, power of	Classroom Lecture and Discussion	3, 4

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
	test; critical region, decision rule by using tabulated value and p-value approaches.		
11-12	**Different types of test statistic:** Z and t for mean test, F for several mean test, variance equal test; and chi-square test statistics for several variance equality test and goodness-of-fit test with applications, sample size estimator for the different types of hypothesis.	Classroom Lecture and Discussion	3, 4
13-14	**Optimal test of hypothesis:** Neyman-Pearson theorem, likelihood ratio test, generalized likelihood ratio test, large sample distribution of the generalized likelihood ratio statistic, uniformly most powerful test.	Classroom Lecture and Discussion	3, 4

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Hogg, R. V. and Craig, A. T. (2018). Introduction of Mathematical Statistics, 8th Edition, Pearson Education.
ii. Cassela, G. and Berger, R. L. (2002). Statistical Inference, 2nd edition, Wadsworth Publishing Co., California.

Supplementary Readings:

i. Mood, A. M., Graybill, F. A. and Bose, D. C. (1974). Introduction to the Theory of Statistics, 3rd edition, McGraw-Hill, New York.
ii. Lehman, E. and Cassela, G. (1998): Theory of Point Estimation, 2nd Edition, Springer Verlag, New York.
iii. Rohatgi, U. K. and Saleh, A. K. Md. E. (2015): An Introduction to the Probability and Statistics, 3rd Editions, John Wiley and Sons Inc., New York.
iv. Devore, J. L. (2000). Probability and Statistics for Engineering and Sciences, 5th edition, Dusbury Press, Boston.

Course Code: 0541-2103	Course Title: Mathematical Analysis and Differential Equations	Course Type: MAT	Credit Value: 3.0	Total Marks: 100

1. Rationale of the Course:

This course is designed to provide a comprehensive understanding of mathematical analysis and differential equations, essential tools in various fields of science and engineering. The course aims to deepen students' knowledge of advanced calculus, real analysis, and the theory and application of differential equations. By bridging theoretical concepts with practical applications, this course will enable students to solve complex mathematical problems and develop analytical thinking skills essential for advanced studies.

2. Course Objectives:

The objectives of this course include:

- To develop a solid understanding of the fundamental concepts and theories in mathematical analysis, including limits, continuity, and convergence.
- To equip students with a thorough understanding of ordinary and partial differential equations, including methods of solving and applications.
- To enhance analytical and problem-solving skills through rigorous examination of various differential equation models and their solutions.
- To provide exposure to real-world applications of mathematical analysis and differential equations in various scientific and engineering contexts.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to demonstrate a comprehensive understanding of core concepts in mathematical analysis, such as limits, sequences, series, and continuity.	3	2	2	1	1
2. Students should be able to apply methods of solving ordinary differential equations (ODEs) and partial differential equations (PDEs) in various contexts and interpret their solutions.	3	3	2	2	1
3. Students should be able to analyze and solve complex problems using advanced techniques in differential equations, including Laplace transforms and Fourier series.	2	3	3	2	2
4. Students should be able to exhibit proficiency to model, solve, and visualize problems involving differential equations.	1	2	3	3	2
5. Students should be able critically assess and apply mathematical analysis and differential equation techniques to real-world problems.	2	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Function of Complex variable:** Functions, Limit, and Continuity of Complex Variable, Differentiability.	Classroom Lecture	1
2-3	**Analytic Function**: Definition, Cauchy Riemann Equations, Singularities, Residue Theorem, Calculus of Residuals.	Classroom Lecture	1
4-5	**Power series of complex functions:** Infinite Series, Taylor's and Laurent's Series, Maclorin Series, Leibnitz's Rule.	Classroom Lecture	1
6-7	**Complex Integration:** Complex Integration, Contour Integration, and Cauchy's Theorem, Cauchy's Integral Formula.	Classroom Lecture	2
8	**Differential Equations**: Definition and its classifications, Initial and Boundary Value problem, Existence Theorem.	Classroom Lecture	2, 3
9-10	**Ordinary Differential Equation:** Equation of First Order and First Degree, Separable Variables, Linear Equation with Constant Coefficients, Exact Equation, Exponential Growth and Decay.	Classroom Lecture and Discussion	2, 4, 5
11-12	**Partial Differential Equations**: First and Second Order, Solution to Differential Equations, Solution in Series.	Classroom Lecture	2, 5
13-14	**Special Functions**: Fourier Transformation and Laplace Transform Legendre, Bessel and Hypergeometric Functions.	Classroom Lecture	3, 4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO 1 to CLO 5	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Rudin, W. (1976). Principles of Mathematical Analysis, 3rd Edition, McGraw-Hill, USA.
ii. Zill, D. G. (2013). A First Course in Differential Equations with Modeling Applications, 10th Edition, Cengage Learning.
iii. Zill, D. G., & Wright, W. S. (2012). Differential Equations with Boundary-Value Problems. Cengage Learning.

Supplementary Readings:

i. Chiang, A. and Wainwright, Kevin (2005). Fundamental Methods of Mathematical Economics, 4th Edition, Mcgraw Hill.
ii. Apostel, T. M. (1974). Mathematical Analysis, 2nd Edition, Norosa, India.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-2104	Database Management System	Core	3.0	100

1. Rationale of the Course:

Database Management Systems (DBMS) are vital components of modern information systems. Database applications are pervasive and range in size from small in-memory databases to terra bytes or even larger in various applications domains. This course introduces database design and creation using a DBMS product. Students should be able to design and implement normalized database structures by creating simple database tables, queries, reports, and forms.

2. Course Objectives:

The objectives of this course include,

- To describe the fundamental elements of relational database management systems.
- To explain the basic concepts of relational data model, entity relationship model, relational database design, relational algebra, and SQL.
- To design ER-models to represent simple database application scenarios.
- To improve the database design by normalization.
- To be familiar with basic database storage structures and access techniques.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will be able to apply analytical skills to develop conceptual database designs and document data standards and dictionary definitions.	3	2	2	1	2
2. Students will be able to create and explain Relational Database models using the Entity Relationship (ER) model and understand fundamental database management elements.	3	3	2	3	2
3. Students will be able to translate logical database designs into specific data models and physical designs to fulfill system storage requirements.	2	3	3	2	2
4. Students will be able to evaluate and utilize features of MSSQL/MySQL/Oracle for maintaining database integrity and performance in enterprise environments.	1	2	3	3	2
5. Students will be familiar with database security principles, access control, backup and recovery.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Introduction:** Database, Purpose of Database, Database Languages, Database Design, Database.	Classroom Lecture	1
2	**Relational Database:** Structure of Relational Database, Database Schema, Schema Diagrams, Relational Query Languages.	Classroom Lecture and Discussion	1, 2

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
3-4	**Introductions to SQL:** Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Set Operations, Joint Expressions, Integrity Constraints, SQL Data Types and Schemas.	Classroom Lecture and Discussion	1, 2, 4
5-6	**Advanced SQL:** Accessing SQL from a Programming Language. Functions and Procedures, Triggers, and Recursive Queries.	Classroom Lecture and Discussion	3,4
7-8	**Database Design Using the E-R Model:** Overview of the Design Process, ER Model, Complex Attributes, Mapping Cardinalities, Primary Key, Removing Redundant Attributes in Entity Sets, Extended ER Features.	Classroom Lecture and Discussion	2, 4
9-10	**Relational Database Design:** Features of Good Relational Designs, Decomposition Using Functional Dependencies, Normal Forms, Functional Dependency Theory, Algorithms for Decomposition, More Normal Forms, Database-Design Process	Classroom Lecture and Discussion	4
11-12	**Complex Data Types:** Semi-structured Data, Object Orientation, Textual Data, Spatial Data.	Classroom Lecture	4, 5
13-14	**Application Development:** Application Programs and User Interfaces, Web Fundamentals, Serlets, Alternative Server-Slide Frameworks, Application Architectures, Application Performance and Securities.	Classroom Lecture and Discussion	5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Silberschatz A., Korth H. F., and Sudarshan S. (2022). Database System Concepts, 7th Edition, McGraw-Hill Education.

Supplementary Readings:

i. Ramakrishnan R. and Gehrke J. (2008). Database Management Systems, 3rd Edition, New York: McGraw-Hill

ii. Hernandez, Michael James. (2013). Database design for mere mortals: a hands-on guide to relational database design. Pearson Education.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-2105	Research Methodology	Core	3.00	100

1. Rationale of the Course:

This course aims to equip students with the fundamental principles and techniques of research methodology, essential for conducting high-quality research in various academic and professional fields. The course covers a broad range of topics, from the formulation of research questions and hypothesis development to data collection, analysis, and interpretation. This course is designed to prepare students for independent research projects and enhance their ability to critically evaluate existing literature and studies.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of Research Methodology and its applications. The specific objectives include:

- To understand the fundamental principles and processes involved in scientific research, including the formulation of research questions and hypotheses.
- To develop skills in designing and implementing research strategies, including qualitative, quantitative, and mixed-method approaches.
- To gain proficiency in data collection techniques, data analysis, and interpretation of research findings.
- To develop the ability to critically evaluate research literature and communicate research findings effectively.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will be able to articulate the principles of research design, including the development of research questions.	3	2	2	1	2
2. Students will be able to design and implement research methodologies qualitative, quantitative, or mixed-method approaches as needed.	3	3	2	3	2
3. Students will be able to demonstrate proficiency in data collection, analysis, and interpretation	2	3	3	2	2
4. Students will be able to recognize and address ethical issues in research, adhering to best practices for responsible conduct in research.	1	2	3	3	2
5. Students will be able to critically evaluate research literature in their field of study and effectively communicate research findings, both orally and in writing, adhering to academic standards.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Basic Concepts of Research Methodology:** Meaning of Research, Objectives, Research Method and Methodology, Concepts of Theory, Proposition, Hypothesis.	Classroom Lecture and Discussion	1
2	**Measurement:** Concept of Measurement, Purpose of Scaling, Types of Scales, Criteria for Good Measurement: Reliability, Validity and Sensitivity, Difference between Reliability and Validity, Tests for Reliability, Different Measures of Validity. **Research ethics:** Ethics in research, Research misconduct, Ethical approval, Protection of human subjects, Conflicts of interest.	Classroom Lecture and Discussion	4, 5
3	**Scaling & Attitude Measurement:** Components of Attitude, Elements of Measuring Attitude, Attitude as a Hypothetical Construct, Techniques for Measuring Attitude, Scaling Techniques of Attitude; Comparative Scales and Non-Comparative Scales. Attitude Rating Scale: Simple Attitude Scale, Category Scale, Summated Ratings Methods - The Likert Scale, Semantic Differential Scale, Numerical Scale, Constant Sum Scale, Stapel, Continuous Rating/Graphic Rating Scale, Behavioral Differential, Paired Comparison Scaling.	Classroom Lecture and Discussion	3, 5
4	**Research Process:** Concepts of Decision Making - Certainty, Uncertainty, Ambiguity. Types of Research: Exploratory, Descriptive and Causal. Stages in Research Process, Research Project vs. Research Program.	Classroom Lecture and Discussion	1, 2
5	**Problem Definition:** The Nature of the Problem, Importance of Problem Definition, Process of Problem Definition. Ascertain the decision maker's objectives, understand the background of the problem, determine the unit of analysis, determine the relevant variables.	Classroom Lecture and Discussion	3
6-7	**Research Design:** Concepts of Research Design, Selection of Appropriate Research Design, Evaluation of Research Design, Types of Research Design: Non-Experimental: Exploratory, Descriptive and Causal Research Designs, Experimental: Pre-Experimental, True-Experimental and Quasi-Experimental Research Designs. Operation Research (OR).	Classroom Lecture and Discussion	1, 2, 5
8-9	**Review of Survey Design and Methods of Data Collection:** Review of Probability and Non-Probability Sampling with Examples. Primary and Secondary Sources of Data. Technique of Data Collection – Quantitative and Qualitative and Mixed-Method Approaches.	Classroom Lecture and Discussion	2

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
10	**Questionnaire Design and Fieldwork:** Questionnaire designing, pretesting, layout for internet questionnaire, administering questionnaire, ethical issues, fieldwork, and fieldwork management.	Classroom Lecture and Discussion	2, 3
11	**Data Management and Analysis:** Stages of Data Preparation Process, Preliminary Plan of Data Analysis, Questionnaire Checking, Editing, Coding, Re-Coding, Data Cleaning, Statistically Adjusting Data, all Statistical Techniques, Including Modelling, and Inference.	Classroom Lecture and Discussion	2, 3
12	**Report Preparation and Presentation:** Literature Review, Report Writing, Oral Presentation, Research Follow-Up, Reference Writing.	Classroom Lecture and Discussion	4, 5
13	**Proposal:** Purpose of Proposal, Types of Research Proposal, Structuring Research Proposal, Evaluation of Research Proposal.	Classroom Lecture and Discussion	4, 5
14	**Monitoring and Evaluation (M&E):** Concept, Indicators, Types of Indicators – Process, Output & Outcome Indicators. Target setting and Methods of Monitoring and Impact Evaluation of Operation Research.	Classroom Lecture and Discussion	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1 to CLO-5	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Zikmund, W. G., Babin, B. J., Carr, J. C. and Griffin, M. (2013). Business Research Methods, 9th Edition, Cengage Learning.
ii. Bell, E., Bryman, A., & Harley, B. (2022). Business research methods. Oxford University Press.

Supplementary Readings:

i. Creswell, J. W., & Creswell, J. D. (2022). Research design: Qualitative, quantitative, and mixed methods approaches. 6th Edition, Sage publications.
ii. Dawson, C. (2019). Introduction to research methods 5th edition: A practical guide for anyone undertaking a research project. Robinson.
iii. Malhotra, N. K. (2006). Marketing Research, 4th Edition, Pearson Education, Singapore.
iv. Babbie, E. (2013). The Practice of Social Research, 13th Edition, Cengage Learning.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-2106	LAB - Application of Statistical Inference	LAB	1.0	100

1. Rationale of the Course:

This lab course offers hands-on experience in statistical inference, bridging theory with real world data analysis. Students will engage with statistical tools and software to conduct analyses and interpret results, enhancing their data-driven decision-making skills in various research contexts.

2. Course Objectives:

The major objectives of this course include:

- To equip students with hands-on experience in applying statistical inference techniques using real-world data.
- To equip students with the ability to interpret and effectively communicate statistical findings for informed decision-making.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will be able to proficiently use statistical software to apply inference techniques, such as hypothesis testing and confidence interval estimation, on real-world datasets.	1	2	2	3	3
2. Students will be able to accurately interpret statistical results and effectively communicate their findings and implications for practical decision-making.	1	3	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-2102: Statistical Inference".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1, 2

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-2107	LAB – Database Management and Application	LAB	1.0	100

1. Rationale of the Course:

This lab course serves as a crucial practical component for students studying database management. It offers hands-on experience in designing, implementing, and maintaining databases.

2. Course Objectives:

The major objectives of this course include:

- To provide students with practical experience in designing, implementing, and maintaining databases using industry-standard database management systems.
- To enable students to apply their knowledge in real-world scenarios by developing database-driven applications and solving database-related challenges.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to apply different available techniques of Database Management and Application.	2	2	2	3	3
2. Students should be able to solve real-world problems using statistical software.	2	3	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0610-2104: Database Management System" using ORACLE, MongoDB, MS Access, etc.	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1, 2

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		

6. Assessment and Evaluation

As per the process outlined in Part D.

Year 2, Semester 2:

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-2201	Advanced Survey Methods	Elective	3.0	100

1. Rationale of the Course:

Advanced Survey Methods is a vital course that equips students with the expertise needed to conduct surveys effectively. It covers advanced survey techniques, data collection, and analysis, ensuring the production of reliable and high-quality data. With broad applications in various fields, from social sciences to market research, this course prepares students to contribute to data-driven decision-making in their future careers. It also keeps them updated with the latest survey technologies, enhancing their professional prospects.

2. Course Objectives:

The specific objectives include:

- To enable students to design surveys that encompass complex data collection strategies, question formats, and sampling techniques.
- To provide students with advanced statistical and analytical skills necessary for processing and interpreting survey data accurately.
- To understand survey research ethics and ensure data integrity and quality.
- To empower students to apply advanced survey methods in diverse fields, meeting sector-specific research requirements.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will demonstrate the ability to design complex surveys.	3	2	2	1	2
2. Students will develop the proficiency in advanced statistical analysis for in-depth survey exploration and interpretation.	3	3	2	3	2
3. Students can learn the fundamental grounding in the use of data reduction and dimensionality reduction techniques.	2	3	3	2	2
4. Students will exhibit a strong understanding of survey research ethics and be capable of ensuring data quality, validity, and reliability throughout the entire survey process.	1	2	2	3	3
5. Students will be able to apply advanced survey methods to diverse fields and addressing the unique research needs and challenges of different sectors.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-2	**Auxiliary Variables:** Concept and Use of Auxiliary Variables. **Ratio and Product Methods of Estimation:** Need for Ratio Estimation, Ratio Estimator for Population Mean/Total with Variance. Product Methods for Estimating Population Mean/Total. Determination of Sample Size for Ratio and Product Methods.	Classroom Lecture and Discussion	1, 2
3-4	**Regression Method of Estimation:** Need for Regression Method of Estimation, Estimator for Population Mean/Total using Estimated Regression Coefficient. Separate and Combined Regression Estimators. Determination of Sample Size for Regression Methods.	Classroom Lecture and Discussion	1, 2
5-6	**Two-Phase/Double Sampling:** Need for Two-Phase Sampling. Two-Phase Sampling in Ratio and Regression Methods, Determination of Sample Size. Two-Phase PPS Sampling.	Classroom Lecture and Discussion	1, 2
7-8	**Sub Sampling:** Reasons for Sub Sampling with Emphasis on Two-stage Sampling. Sub Sampling with Units of Equal and Unequal Sizes. Sub Sampling with Units Selected with Equal Probabilities-Unbiased Estimator, Units Selected with Equal Probabilities-Ratio to Size Estimate, Estimation Using SRSWOR at both the Stages, Estimation using PPSWR And SRSWOR. Determination of Sample Size.	Classroom Lecture and Discussion	3, 4
9	**Sampling from Mobile Populations:** Concept of Mobile Population, estimation of Population Size Using Direct and Inverse Sampling. Determining Sample Sizes.	Classroom Lecture and Discussion	4, 5
10	**Sampling from Hard-to-Reach Populations:** Concept of Hard-to-Reach/Hidden Populations, Network Sampling, Respondent Driven Sampling (RDS). Network Scale Up Method for Estimating Population Size.	Classroom Lecture and Discussion	4, 5
11	**Sampling on More Occasions:** Longitudinal Surveys, Repetitive Surveys, Adaptive Surveys.	Classroom Lecture and Discussion	4, 5
12-13	**Errors in Survey:** Concept of errors in Survey, Sampling Error, Non-Sampling Error. Non-Response Error, Measurement Error, Processing Error, Characteristics of Non-Response, Measuring Non-Response, Dealing with	Classroom Lecture and Discussion	4, 5

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
	Non-Response, Perspectives on Non-Response, Estimation in Presence of Unit Non-Response. Methods of Reducing Non-Response and Response Errors, Observational Errors.		
14	**Selected Census and Surveys in Bangladesh:** Population and Housing Census, Economic Census, Agriculture Census. Households Income & Expenditure Survey, Demographic Health Survey, MICS, Agriculture Survey, Forest Survey.	Classroom Lecture and Discussion	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Raj, D. and Chandhok, P (1998). Sample Survey Theory, Narosa Publishing House, New Delhi.
ii. Thompson, S. K. (2012). Sampling, 3rd Edition John Wiley, New York.

Supplementary Readings:

i. Sampath, S., (2005). Sampling Theory and Methods. 2nd Edition, Alpha Science.

i. Chudhuri, A. and Stenger, H. (2005). Survey Sampling Theory and Methods, 2nd Edition, Chapman and Hall/CRC.
iii. Hansen, M. H., Hurvitz, W. N. and Mado, W. G. (1953). Sample Survey Methods and Theory, Vol. I and Vol. II, Wiley, New York.
iii. Cochran, W. G. (2002). Sampling Techniques, 4th Edition, Wiley Eastern, New Delhi.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-2202	Linear Regression Models	Core	3.0	100

1. Rationale of the Course:

Statistics deal with different types of real-life problems. Sometimes it is very important to know about the relation between two variables. Different techniques are available in Statistics to know in detail the relationship among different types of variables. The course provides an overview of the most common techniques used to quantify correlation and regression analysis and to establish relationship and model-building techniques.

2. Course Objectives:

The objectives of this course are to apply and fit appropriate regression models according to the nature of the data. The specific objectives include:

- To gain in-depth knowledge of the theoretical foundations and assumptions underlying correlation and linear regression analysis.
- To acquire hands-on experience in applying linear regression methods to real-world datasets, focusing on data preprocessing, model fitting, and result interpretation.
- To learn diverse metrics for assessing model performance, enabling critical evaluation and selection of appropriate regression models.
- To translate regression analysis outcomes into actionable insights, enhancing the ability to make data-driven decisions in various fields and industries.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will demonstrate a deep understanding of the theoretical principles and assumptions underpinning linear regression analysis.	3	2	2	1	1
2. Students will apply correlation and linear regression models to real-world datasets, demonstrating proficiency in data preprocessing, model fitting, and interpretation of results.	3	3	2	3	2
3. Students will evaluate the performance of regression models using appropriate metrics and statistical tests, demonstrating the ability to assess the quality of predictions.	2	3	3	2	2
4. Students will explore and apply advanced regression techniques, including multiple linear regression and regularization, to handle complex modeling scenarios.	1	2	3	3	2
5. Students will translate regression analysis results into actionable insights for decision-making, demonstrating the ability to draw meaningful conclusions and recommendations from the data.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Correlation Analysis:** Bivariate frequency distribution, graphical presentation of bivariate data, concept of association between two variables and scatter diagram. Covariance, Correlation Analysis. Pearson Correlation Coefficient.	Classroom Lecture and Discussion	1
2	Serial and bi-serial correlation, spurious correlation, Kendall's tau correlation, fourfold and tetrachoric correlation, assumption and properties of multiple, partial correlations, and inference concerning the correlation.	Classroom Lecture and Discussion	1, 2
3	**Simple Linear Regression Model:** Simple linear regression model, Assumption of the model, OLS estimation, Properties of OLS estimator, interpretation of results. Hypothesis testing on the slope and intercept, interval estimation, prediction of new observations, and coefficient of determination, Adjusted R^2.	Classroom Lecture and Discussion	2
4	Regression through the origin, Parameter estimation by maximum likelihood, Properties of MLE estimator.	Classroom Lecture and Discussion	2,3
5	**Multiple Regression Models**: Multiple regression models, estimation of the model parameters.	Classroom Lecture and Discussion	3,4
6	Hypothesis testing in multiple linear regression. Confidence intervals in multiple regression, prediction of new observations, and hidden extrapolation in multiple regression.	Classroom Lecture and Discussion	4, 5
7	**Regression for Binary Data:** Logistic Regression, Estimation and Interpretation of Coefficients.	Classroom Lecture and Discussion	3,4,5
8	**Examination of Residuals & Selection of Best Regression Equation:** Residual analysis, PRESS Statistic, Detection and Treatment of Outliers.	Classroom Lecture and Discussion	3,4,5
9	Lack of fit and pure error of the regression model, test of lack of fit and pure error of the model.	Classroom Lecture and Discussion	3,4,5

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
10	Importance of detecting influential observations, leverage, measures of influence, Cook's D.	Classroom Lecture and Discussion	3,4,5
11	**Measures of influence:** DFFITS, DFBETAS, and related topics.	Classroom Lecture and Discussion	3,4,5
12	Measure of model performance, detecting groups of influential observations, treatment of influential observations.	Classroom Lecture and Discussion	3,4,5
13	**Selection of Best Regression Equation:** All Possible Regression, Best Set of Regression, Backward Elimination Procedure, Stepwise Regression Procedure, Ridge Regression	Classroom Lecture and Discussion	3,4,5
14	**Count Regression:** Poisson Regression, Binomial Regression, Negative Binomial Regression.	Classroom Lecture and Discussion	3,4,5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests, and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Montgomery, D. C., Peck, E., and Vining G. G. (2021). Introduction to Linear Regression Analysis, 6th Edition, Wiley, N.Y.

Supplementary Readings:

i. Frost, J. (2020). Regression analysis: an intuitive guide for using and interpreting linear methods. Statistics By Jim Publishing.
ii. Draper, N. R, and Smith, H. (1998). Applied Linear Regression, 3rd Edition, John Wiley & Sons, New York.
iii. Ryan, T. P. (2009). Modern Regression Methods, 2nd Edition, Wiley Publishing, New Jersey.
iv. Chatterjee, S. and Hadi, A. S., (2012): Regression Analysis by Example, 5th Edition, Wiley.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-2203	Stochastic Processes	Elective	3.00	100

1. Rationale of the Course:

Stochastic models are widely applied in the fields of engineering, computer science, management science, the physical and social sciences and operation research. Thus, this course will provide students with a solid theoretical foundation in stochastic processes and equip them with the skills necessary to apply these concepts to various fields of study and research.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of the Stochastic Processes and its applications. The specific objectives include:

- To gain a fundamental understanding of stochastic processes as a mathematical framework for modeling random phenomena evolving over time
- To explore concepts associated with stochastic processes, including stationarity, independence, and the Markov property.
- To learn the application of different types of stochastic processes including Counting Processes, Poisson processes, Renewal Processes
- To learn how to model and analyze real-world phenomena using stochastic processes. Explore applications in finance, biology, telecommunications, and other fields.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will gain foundational knowledge of stochastic processes for modeling time-evolving random phenomena.	3	2	2	1	2
2. Students will learn master key concepts like stationarity, independence, and the Markov property in stochastic processes.	3	3	3	3	2
3. Students will apply various stochastic processes such as Counting, Poisson, and Renewal Processes in real-life scenarios	1	3	3	3	3
4. Students will develop skills to model and analyze phenomena using stochastic processes across fields like finance, biology, and telecommunications.	1	3	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Stochastic Process – Definitions & Descriptions:** Definition of Stochastic Process, State Space and	Classroom Lecture and Discussion	1

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
	Parameter Set. Description of different types of Stochastic Processes. Concept of Mean Value Function, Variance Function, Covariance Function, and Second Order Process. Process with Independent Increments, Stationary Process, and Martingales.		
2	**Markov Chains:** Definition of Markov Chain, Transition probabilities and Matrix of Transition Probabilities. Order of a Markov Chain, Graphical representation of Markov Chain.	Classroom Lecture and Discussion	1, 2
3-4	Determination of Higher Transition Probabilities. Classification of States and Chains, Properties of Communication of States, First Entrance Decomposition Formula, Ergodic Properties of Irreducible Chains.	Classroom Lecture and Discussion	1,2
5-7	**Counting Process and Poisson Process:** Basic concept of Counting Process. Poisson Process, Postulates for Poisson Process and Properties of Poisson Process. Interarrival Time and Waiting Time Distribution, Conditional Distribution of Inter-Arrival Time, Compound Poisson Process, Non-Homogeneous Poisson Process.	Classroom Lecture and Discussion	1, 3
8	**Continuous Time Markov Chains:** Concept of Continuous Time Markov Chain, Transition Probability Function & its Properties.	Classroom Lecture and Discussion	1, 3
9-10	Birth and Death Process, Kolmogorov Differential Equations and Limiting Probabilities.	Classroom Lecture and Discussion	1,3
11	**Queuing Theory:** Characteristics of Queuing System, Cost Equations, Steady State Probabilities.	Classroom Lecture and Discussion	1, 3, 4
12	**Markovian Queuing Models:** Single Server Queuing Models having infinite and finite capacity, Distribution of Time spent on queue & in the system, Queuing process with bulk services.	Classroom Lecture and Discussion	1, 3, 4
13	**Multi-server Queuing Models:** Multi-server Queuing Models have infinite and finite capacity. Erlang's Loss System.	Classroom Lecture and Discussion	1, 3, 4

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
14	**Non-Markovian Queuing Models:** Network of Queues, M/G/1, G/M/1, G/G/1 System. Concept of Multi-server Queues: M/G/K, G/M/k, and G/G/k Queue Systems.	Classroom Lecture and Discussion	1,3, 4

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Medhi, J. (2020). Stochastic Process, 5th edition, New Age International (P) Ltd., Publishers, New Delhi.
ii. Ross, S., M. (2023). Introduction to Probability Models, 13th edition, Academic Press, an imprint of ELSEVIER, USA.

Supplementary Readings:

i. Bhat, B., R. (2004). Stochastic Models, Analysis and Applications, 2nd Edition, New Age International (P) Ltd., Publishers, New Delhi.
ii. Medhi, J. (2006). Stochastic Models in Queuing Theory, 2nd edition, Academic Press, an imprint of ELSEVIER, USA.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-2204	Industrial Statistics	Core	3.0	100

1. Rationale of the Course:

This course is designed to equip students with statistical methods and tools relevant to industrial applications. The focus is on practical data analysis, quality control, and decision-making skills, vital for industries such as manufacturing, engineering, and quality assurance. Emphasis is placed on real-world problem solving, data-driven decision making, and the application of statistical techniques to improve industrial processes.

2. Course Objectives:

The objectives of this course include:

- To learn the definition, characteristics, scope, and limitations of industrial statistics and quality control.
- To develop a mastery of concepts in quality, total quality control, and statistical quality control, including the causes of variation.
- To learn in-depth about control charts, their construction, types, and analysis, including charts for variables and attributes.
- To understand the basic concepts of acceptance sampling, including single and double sampling plans, and the design and application of these plans.
- To explore advanced topics such as Operations Research, Linear Programming, Game Theory, and Network and Inventory Models.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will have a foundational understanding of industrial statistics and quality control, recognizing their application in real-world scenarios	3	2	2	1	3
2. Students will be able to apply quality control techniques effectively, analyze causes of variation, and implement statistical process control.	3	3	2	3	2
3. Students will gain skills in creating and analyzing various types of control charts, understanding their statistical basis and practical applications.	2	3	3	2	2
4. Students will master the concepts and practical applications of acceptance sampling, including designing and analyzing single and double sampling plans.	1	2	3	3	3
5. Students will develop a deep understanding of advanced statistical topics like Operations Research, Linear Programming, Game Theory, and Network and Inventory Models, and their applications in industrial settings.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Industrial Statistics & Quality Control:** Definition, characteristics, scope, and limitations of industrial statistics. Quality, quality control, total quality control; statistical quality control; causes of variation; chance and assignable causes of variation; statistical process control.	Classroom Lecture and Discussion	1, 2
2-4	**Control chart:** Concept of control chart; statistical basis of the control chart; basic principles; choice of control limits; analysis of patterns on control charts; sensitizing rules for control charts; necessary steps for constructing control charts; types of control charts; basic concepts of control charts for variables; statistical basis and interpretation of mean, R and S charts; control charts for attributes: concepts of nonconformity; nonconforming unit; defect; defective unit; p-chart; d-chart; c-chart; u-chart	Classroom Lecture and Discussion	3
5-7	**Acceptance sampling:** Basic concepts of acceptance sampling; types; lot formation; guidelines of using acceptance sampling; OC curve and its uses; types of OC curves; properties of OC curves. **Single sampling plan:** basic concepts of single sampling plan for attributes; construction of type A and type B OC curves under single sampling plan for attributes; specific points on the OC curve (AQL, LTPD); rectifying inspection; AOQ; AOQL; ATI; ASN; designing a single sampling plan. **Double sampling plan:** basic concepts of double sampling plan; OC curve; ASN; AOQ; ATI; designing a double sampling plan; introduction to multiple sampling plan and sequential sampling analysis; acceptance sampling plan by variables; designing a variable sampling plan with a specified OC curve; sequential sampling by variables, chain sampling etc.	Classroom Lecture and Discussion	4
8-10	**Basic Concept of OR:** Definition, characteristics, scope and limitations, problem formulation and modeling, classification of operations research (OR). **Linear Programming:** Concept of linear programming problem (LPP); construction of LPP; solution of LPP; graphical and the simplex method; revised simplex method; big-M method; two phase method; duality problems of LPP; transportation problem.	Classroom Lecture and Discussion	4, 5

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
11-12	**Game Theory:** Introduction, properties of two persons zero-sum game, maximum minimum principle, pure and mixed strategy games, two-person zero-sum and its relation with linear programming and non-zero-sum games, solution of the game by graphical methods, simplex method, approximate solution of the game by Brown's Algorithm.	Classroom Lecture and Discussion	4, 5
13-14	**Network and Inventory Models:** Scope and definition of network models, Minimal Spanning Tree Algorithm, Shortest-Root Problem, Maximal Flow Model, CPM, and PERT. Deterministic and Probabilistic Inventory Models, Role of Demand in the Inventory Models, Static and Dynamic, Economic-Order-Quality (EOQ), Single Period Models, Multi-Period Models.	Classroom Lecture and Discussion	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Montgomery, D. C. (2020). Introduction to Statistical Quality Control, 8th Edition, John Wiley and Sons, New York.
ii. Taha, H. A. (2022). Operations Research: An Introduction, 11th Edition, Prentice-Hall: New Delhi.

Supplementary Readings:

i. Duncan, A. J. (1986). Quality Control and Industrial Statistics, 5th Edition, Richard D. Irwin, Homewood, Illinoy.
ii. Banks, J. (1989). Principles of Quality Control, John Wiley and Sons, New York.
iii. Gass, S. I. (1985). Linear Programming Methods and Applications, 5th Edition, Mcgraw-Hill Ltd., New York.
iv. Karak, P. M. (1991). Linear Programming and Theory of Games, Chhaya Prakashani, India.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-2205	LAB – Programming and Data Analysis Using R	LAB	2.0	100

1. Rationale of the Course:

Acquiring knowledge in R programming is widely used in statistical computing, data analysis, and visualization, making it indispensable for statisticians and data analysts. For professionals working in data science, statistics, and research, R is an essential tool because it offers a strong and adaptable environment for statistical modeling, hypothesis testing, and data exploration.

2. Course Objectives:

The major objectives of this course include:

- To equip students with the ability to apply R programming for effective data manipulation, visualization, and analysis.
- To develop skills in control structures (loops, conditionals) to implement precise logic and flow control in R scripts, enhancing code efficiency.
- To learn how to write and use R functions to create modular and reusable code that facilitates efficient processes for data analysis.
- Learn how to handle, clean, and transform data effectively for statistical analysis using R's advanced data manipulation techniques and packages.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will be able to learn mathematical and logical operators of R.	1	2	2	3	1
2. Students will be able to use core functionalities of R for a holistic data analysis approach	1	2	2	3	1
3. Students will be able to create meaningful and insightful data visualizations using R.	1	1	2	3	3
4. Students will gain the ability to use different functions, conditional statement and loops.	1	2	2	3	3
5. Student will apply R skills to real-world scenarios, proficiently managing datasets, conducting statistical tests, and demonstrating practical R application in diverse contexts.	1	1	1	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Introduction to R:** R Software and RStudio installation and a brief description of the software, R basics including Package installation, Package updating, and Package Removing.	Computer intensive lab	1
2-3	**R language essentials:** Expressions, Using mathematical and logical operators, built-in functions, arguments, vectors.	Computer intensive lab	1, 2

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
4-5	**Data manipulation**: Data cleaning techniques, Reading and writing Data from different Sources and manipulating the data, Data sub setting, filtering, sorting, deleting missing value	Computer intensive lab	2, 3
6	**Data structures in R:** Functions that create vectors, matrices and arrays, factors, lists, data frames, indexing, grouped data, and finding help.	Computer intensive lab	2, 3
7	**Conditions:** Conditional executions, comparison operators, if and if else statements	Computer intensive lab	3,4
8	**Looping:** For, While, Do loop improving the speed performance of loops	Computer intensive lab	3,4
9	**Functions:** Syntax to define and call functions, Syntax rules for functions	Computer intensive lab	3,4
10	**Data visualization:** ggplot2 and interactive dashboards with Shiny.	Computer intensive lab	3, 4
11-13	**Advanced data analysis:** Basic statistics with R: Descriptive statistics, hypothesis testing, Correlation, Regression, ANOVA, and time-series analysis	Computer intensive lab	4
14	**Hypothesis testing:** One-sample and two-sample t-tests, Paired t-test, Constructing CIs for population parameters, Interpreting the practical significance of CIs, P-values, and significance	Computer intensive lab	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1 to CLO-5	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Wickham, H., and Grolemund, G. (2023). R for Data Science: Import, Tidy, Transform, Visualize, and Model Data. 2nd Edition, O'Reilly Media, Inc.
ii. Jones, E., Harden, S. and Crawley, M. J. (2022). The R book. 3rd Edition, John Wiley & Sons.

Supplementary Readings:

i. Metzler, N. (2019). R Programming for Beginners: An Introduction to Learn R Programming with Tutorials and Hands-On Examples. Independently published.
ii. Peng RD (2016). Exploratory Data Analysis with R. Leanpub.
iii. Matloff, N. (2011). The Art of R Programming: A Tour of Statistical Software Design. No Starch Press.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-2206	LAB - Field Work on Survey Methods	LAB	1.0	100

1. Rationale of the Course:

This course is designed to provide students with practical experience in designing and conducting surveys to gather primary data from the field.

2. Course Objectives:

The major objectives of this course include:

- To enable students to gain hands-on experience in administering and conducting surveys in real-world settings, thereby fostering their ability to apply theoretical survey methodologies to practical fieldwork scenarios.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to develop the proficiency to design and execute comprehensive survey plans, enabling them to collect accurate data, analyze survey results, and draw meaning conclusions for various research and decision-making purposes.	3	2	2	2	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical courses "Survey Methods".	Fieldwork, Data Collection and Analysis	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Field work, Data Collection and Analysis	**Field report and Presentation.**

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-2207	LAB - Applications of Linear Regression Models	LAB	1.0	100

1. Rationale of the Course:

To learn the practical applications of the analytical techniques of regression analysis along with the statistical software SPSS and R.

2. Course Objectives:

The major objectives of this course include:

- To explore different available techniques of regression analysis in real-world problems using statistical software to build a strong and efficient statistical background in the corresponding areas.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to fit different regression models etc.	1	2	2	3	2
2. Students should be able to Test the of Significance different correlation and regression coefficients, the test of influential and outliers, the test for Serial Correlation, etc.	1	3	2	3	2

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-2202: Linear Regression Models".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1,2

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-2208	LAB - Industrial Statistics and Optimization in Python	LAB	1.0	100

1. Rationale of the Course:

This course is designed to equip students with the essential statistical and optimization tools required to address challenges in industrial settings. By leveraging Python's versatile programming capabilities, students can effectively analyze and interpret complex datasets commonly encountered in industrial environments.

2. Course Objectives:

The major objectives of this course include:

- To familiarize students with the application of statistical methods in industrial environments, interpret data to make informed decisions.
- To learn various optimization algorithms and their applications in solving complex industrial problems, such as production planning, resource allocation, supply chain management, and logistics optimization.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to conduct comprehensive industrial data analysis using statistical tools and techniques in Python.	3	2	2	1	2
2. Students should be able to apply optimization techniques in solving complex industrial problems.	3	3	2	3	2

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-2204: Industrial Statistics".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1, 2

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		

6. Assessment and Evaluation

As per the process outlined in Part D.

Year 3, Semester 1:

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-3101	Advanced Statistical Inference	Elective	3.0	100

1. Rationale of the Course:

This course is designed to deepen students' understanding of advanced statistical inference techniques. It focuses on more complex estimation methods, resampling techniques, and hypothesis testing. The course covers a range of topics from the estimation of multiple parameters and resampling methods like Jackknife and Bootstrap, to various tests of hypotheses and sequential analysis. This course is crucial for students aiming to excel in fields requiring rigorous statistical analysis and offers practical insights into the application of these methods in real-world scenarios.

2. Course Objectives:

The specific objectives of this course include:

- To learn advanced estimation methods, including median and modal unbiased estimators, and simultaneous estimation of several parameters.
- To develop an understanding of resampling techniques, e.g., Jackknife and Bootstrapping.
- To learn about robust estimation techniques, including location invariance and Pitman estimators for location and scale.
- To emphasis statistical inference on practical aspects of the interpretation and communication of statistically based conclusions in real data applications.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will demonstrate mastery in advanced estimation techniques.	3	2	2	1	1
2. Students will gain proficiency in resampling techniques, specifically the Jackknife and Bootstrapping methods.	3	3	2	3	2
3. Students will develop skills in robust estimation techniques, including the Pitman estimator for location and scale.	2	3	3	2	2
4. Students will gain expertise in conducting various types of hypothesis tests.	1	2	2	3	3
5. Students will understand the principles of sequential analysis, including SPRT and its efficiency.	2	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-2	**Estimation:** Median and modal unbiased estimator, simultaneous estimation of several parameters, vectors of parameters, ellipsoid of concentration, Wilk's generalized variance.	Classroom Lecture and Discussion	1

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
3-4	**Resampling:** Jackknife and Bootstrapping techniques.	Classroom Lecture	2
5-6	**Lower bounds:** Chapman-Robinsons-Keiffer lower bound, generalized Rao-Cramer lower bound, Bhattacharya's system of lower bound.	Classroom Lecture and Discussion	1
7	MLE in truncated and censored distributions, general set up in estimation.	Classroom Lecture	1
8-9	Location, invariance, Pitman estimator for location, Pitman estimator for scale, robust estimation.	Classroom Lecture	3
10-11	**Test of hypothesis:** Randomized tests, consistent tests, unbiased tests, Most powerful test, uniformly most powerful (unbiased) test, locally uniformly most powerful unbiased test, optimal tests in different situations,	Classroom Lecture and Discussion	4, 5
12	**Likelihood-based tests:** Wald test, Score test (LM test), likelihood ratio test.	Classroom Lecture	4, 5
13-14	**Sequential analysis:** Concept, SPRT, the efficiency of SPRT, fundamental identity of the sequential analysis, O.C. function of the sequential plan, ASN function.	Classroom Lecture	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1 to CLO-5	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Cassela, G. and Berger, R. L. (2002). Statistical Inference, 2nd Edition, Wadsworth Publishing Co., California.
ii. Lehman, E. and Cassela, G. (1998): Theory of Point Estimation, 2nd Edition, Springer Verlag, New York.
iii. Lehman, E. L. (1997): Testing Statistical Hypothesis, 2nd Edition, Springer-Verlag, New York.

Supplementary Readings:

i. Hogg, R. H., McKean, J. W. and Craig, A. T. (2018). Introduction to Mathematical Statistics, 8th Edition, Pearson Education, Asia.
ii. Rohatgi, U. K. and Saleh, A. K. Md. E. (2015): An Introduction to the Probability and Statistics, 3rd Editions, John Wiley and Sons Inc., New York.
iii. Efron, B. (1982). The Jackknife, the Bootstrap and other Resampling Plans. SIAM Publications Library, Philadelphia.

Course Code:	Course Title:	Course Type:	Credit Value: 3.0	Total Marks:
0542-3102	Econometrics	Core		100

1. Rationale of the Course:

The Econometrics course is designed to provide students with a comprehensive understanding of econometric theories and methods. It focuses on the methodologies used in econometric analysis, challenges like multicollinearity, heteroscedasticity, and autocorrelation, and the application of advanced econometric models. This course is essential for students pursuing careers in economics, finance, and data analysis, as it equips them with the skills needed to analyze complex economic data and build accurate models for forecasting and policy evaluation.

2. Course Objectives:

The objective of this course includes,

- To learn the basic concepts, methodology, and types of econometrics, including the role of data and computers in econometric analysis.
- To understand the nature and consequences of multicollinearity and to learn how to detect and remedy it.
- To learn about heteroscedasticity, its detection, and remedial measures using various statistical tests and methods.
- To gain an understanding of autocorrelation, its consequences in econometric models, and the application of dynamic econometric models.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will develop proficiency in the basic concepts and methodologies of econometrics.	3	3	2	1	3
2. Students will be skilled in identifying and addressing multicollinearity in econometric models, using theoretical and practical approaches.	3	3	2	3	2
3. Students will have the ability to detect heteroscedasticity using various methods and apply remedial measures like Weighted Least Squares to correct it.	2	3	3	2	2
4. Students will understand the implications of autocorrelation in econometric models.	3	2	3	3	2
5. Students will be able to apply dynamic econometric models, including autoregression and distributed lag models, and utilize methods for estimating these models effectively.	3	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Basic Concept of Econometrics:** Meaning, Methodology of Econometrics, Types of Econometrics, Nature and Source of Data for Econometric Analysis, Role of Computer in Econometric Analysis.	Classroom Lecture and Discussion	1
2-3	**Multicollinearity:** Nature of Multicollinearity, Estimation in Presence of Multicollinearity, Consequences, Detection, and Remedial Measures of Multicollinearity.	Classroom Lecture and Discussion	2
4-5	**Heteroscedasticity:** Nature of Heteroscedasticity, Estimation in Presence of Heteroscedasticity, Consequences of Using Ordinary Least Squares in Presence of Heteroscedasticity, Detection of Heteroscedasticity by Informal and Formal Methods, Remedial Measures.	Classroom Lecture and Discussion	3
6-7	**Autocorrelation (Serial Correlation):** Nature, Estimation in the Presence of Autocorrelation, Consequences of Using OLS in the Presence of Autocorrelation, Detection of Autocorrelation by Graphical and Formal Methods, Remedial Measures, Concept of ARCH, GARCH Model. **Monte-Carlo Experiment:** Consequence of Autocorrelation.	Classroom Lecture and Discussion	4
8	**Econometric Modeling:** Specification Errors, Types of Specification Error, Nature, Consequences and Remedies of Specification Errors, Test of Specification Error, Errors of Measurement in Dependent and Explanatory Variables.	Classroom Lecture and Discussion	5
9-10	**Model Selection:** Leamer's and Hendry's Approach to Model Selection, Non-Nested Hypothesis Test by (i) Discrimination Approach (ii) Discerning Approach and (iii) Other Criteria.	Classroom Lecture and Discussion	5
11-12	**Regression for dummy dependent variables:** Detail Study of Linear Probability, Logistic, Probit and Tobit Models for Dummy Dependent Variables.	Classroom Lecture and Discussion	5
13	**Dynamic Econometric Model:** Autoregression, Distributed Lagged Variables, Lag Model, Method of Estimation of Lag and Distributed Lag Model, Median Lag of Different Models, Method of Instrumental Variable, Detecting Autocorrelation in Autoregressive Model.	Classroom Lecture and Discussion	5

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
14	**Non-Linear Least Squares:** Cobb-Douglas and CES Production Functions, Estimation of Cobb-Douglas Production Function Parameters. **Input-Output Analysis**, Internal Efficiency.	Classroom Lecture and Discussion	5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

ii. Gujarati, D. N. and Poter, D. (2009). Basic Econometrics, 5th Edition, McGraw-Hill, New York.

iii. Wooldridge, J. M. (2019). Introductory Econometrics: A Modern Approach, 7th Edition, Cengage Learning, South-Western.

Supplementary Readings:

i. Judge, G. G. H, R. C., Griffiths, W. E., Lütkepohl, H. and Lee, T. C. (1988). Introduction to the Theory and Practice of Econometrics, 2nd Edition, John Wiley and Sons, New York.

ii. Cameron, A. C. and Trivedi, P.K. (2005). Microeconometircs- Methdos and Application, Cambridge University Press, UK

iii. Johnston, J. and Dinardo, J. (1997). Econometric Methods, 4th Edition, Mcgraw-Hill, New York.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-3103	Data Structures and Visualization	Core	3.0	100

1. Rationale of the Course:

This course on data structures and visualization is valuable for students seeking a robust understanding of core computer science concepts, problem-solving skills, and the ability to convey data-driven insights effectively in various professional contexts. It prepares students for a wide range of career opportunities and provides essential skills for both technical and non-technical roles.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of data structures and visualization with their applications using **Python and R**. The specific objectives include:

- To understand the fundamental concepts of data structures and their importance in data analysis.
- To design and implement common data structures, including arrays, linked lists, stacks, and queues.
- To master the use of data visualization libraries and tools to generate effective and engaging visualizations.
- To integrate data structures and data visualization techniques to preprocess and prepare data for effective visualization.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to apply appropriate data structures to solve real-world problems.	3	2	2	1	2
2. Students should be able to write efficient and well-structured code to work with data structures.	3	3	2	3	2
3. Students should be able to select and create appropriate data visualizations, such as bar charts, scatter plots, and heatmaps based on data types.	2	3	3	2	2
4. Students should be able to create interactive data visualizations and dashboards to enable user exploration and understanding.	1	2	3	3	2
5. Students should be able to apply data structures and data visualization skills to analyze and visualize real-world datasets and scenarios.	1	3	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Introduction to Data Structures:** Overview of data structures, why data structures matter, Types of data structures, Role of data structures in data science	Classroom Lecture and Discussion	1

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
2-4	**Lists, Arrays, and Linked Lists:** Arrays and lists, implementing arrays and lists in Python, Linked lists: singly and doubly linked lists, Use cases and applications of lists and linked lists	Classroom Lecture and Discussion	1, 2
5-7	**Stacks and Queues:** Understanding stacks and queues, implementing stacks and queues, Use cases: function call stack, task scheduling, etc.	Classroom Lecture and Discussion	3
8-10	**Trees and Graphs:** Tree data structures: binary trees, binary search trees, Introduction to graphs, Traversing trees and graphs, Applications in network modeling and hierarchical data	Classroom Lecture and Discussion	3, 4
11-12	**Data Visualization Principles:** Introduction to data visualization, Perception and cognition in data visualization, Choosing right visualization for data	Classroom Lecture and Discussion	4
11-12	**Data Visualization Tools:** Introduction to data visualization libraries (e.g., Matplotlib, Seaborn), Creating basic data visualizations: bar charts, line charts, scatter plots, etc., Customizing visualizations for clarity	Classroom Lecture and Discussion	4, 5
13-14	**Interactive Data Visualization:** Interactive data visualization libraries (e.g., Plotly, Bokeh), Building interactive dashboards	Classroom Lecture and Discussion	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1 to CLO-5	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Michael, T., Goodrich, Roberto, T., and Michael H. G. (2013). Data Structures and Algorithms in Python, Wiley.
ii. Nathan, Y. (2013). Data Points: Visualization That Means Something, Wiley.

Supplementary Readings:

i. Benjamin, B. (2017). Python Data Structures and Algorithms, Packt Publishing.
ii. Rahman, A., Abdulla, F., & Hossain, M. M. (2024). Scientific Data Analysis with R: Biostatistical Applications. Chapman & Hall/CRC Press.
iii. Edward, R. T. (2001). The Visual Display of Quantitative Information, 2nd edition, Graphics Press.

Course Code:	Course Title:	Course Type:	Credit Value: 3.0	Total Marks:
0412-3104	Financial Management & Actuarial Statistics	GED		100

1. Rationale of the Course:

This course is crucial in today's dynamic and uncertain financial landscape. Financial Management encompasses the principles and techniques for effective financial decision-making, which are essential for both individuals and organizations. Actuarial Statistics, on the other hand, plays a vital role in managing and mitigating financial risks, particularly in the context of insurance and pension planning. This combined curriculum provides a comprehensive understanding of financial management, risk assessment, and actuarial science.

2. Course Objectives:

The objective of this course includes:

- To gain a deep understanding of financial decision-making principles and practices.
- To develop proficiency in analyzing financial statements for informed decision-making.
- To explore financial markets, instruments, and the dynamics of stock markets.
- To delve into the assessment and management of financial risks and the application of actuarial statistics.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to understand the fundamental concepts of financial management and actuarial statistics and their applications in associated fields.	3	2	2	1	2
2. Students should be able to identify and apply the fundamental theory of market, risk management, interest, insurance, etc. and how they influence financial sectors.	3	3	2	3	3
3. Students should be able to learn mathematical and statistical models used in financial management and actuarial science.	2	3	3	2	2
4. Students should be able to analyze real-world financial and actuarial cases.	1	2	3	3	3
5. Students will have a solid grasp of actuarial principles and apply actuarial mathematics to pension plan funding and valuation.	3	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Overview of Financial Management:** Definition and scope of financial management. **Financial Statement Analysis:** Concept, Types and Importance of financial statements, Financial Statement Analysis Techniques - Horizontal and Vertical Analysis, Ratio Analysis.	Classroom Lecture and Discussion	1
2	**Financial Markets and Instruments:** Overview of Financial Markets - Money market, Capital market, Derivatives market. Financial Instruments - Stocks, bonds, and derivatives, Exchange-traded funds (ETFs). Behaviour of Stock market Pricing and Modelling.	Classroom Lecture and Discussion	2
3	**Theory of Interest:** Concept of simple interest and compound interest. Determinants of interest rate, forecasting of interest rate. Term Structure of interest rate. Force of Interest.	Classroom Lecture and Discussion	2, 3
4-6	**Time Value of Money:** Concept of Present value and Future value, Discounting and Compounding. Types of Cash-flow – Single Lump Sum Amount, Annuity. Meaning of annuities; types of annuities. Certain, present and future values of different types annuities, e.g., ordinary annuity, annuity due; perpetuities, continuous and varying annuities. **More frequently compounding and discounting:** Concept; Effective, Periodic and Nominal rates and their interrelationship.	Classroom Lecture and Discussion	2, 3
7	**Risk and Return:** Definition and types of financial risks - market risk, credit risk and liquidity risk. Importance of risk assessment and management in financial decision-making. Portfolio theory, Capital Asset Pricing Model (CAPM).	Classroom Lecture and Discussion	2, 3
8	**Capital Budgeting Techniques:** Net Present Value (NPV), Internal Rate of Return (IRR), Payback period.	Classroom Lecture and Discussion	3
9	**Actuarial Statistics** **Basic Concept of Actuarial Statistics:** the meaning of actuarial science; role of an actuaries in risk management; its relationship with life insurance; uses of actuarial statistics especially in context of Bangladesh.	Classroom Lecture and Discussion	4, 5

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
10-11	**Life Annuity and Insurance:** Economics of insurance, types of insurance; utility theory, application of probability to problems of life and death. Determination of single premium for insurances and annuities in both discrete and continuous cases.	Classroom Lecture and Discussion	4, 5
12	**Capital Redemption Policies:** Amortization and amortization schedule; sinking funds; relationship between amortization and sinking funds; bonds; book values; yield rates and mortgages.	Classroom Lecture and Discussion	4, 5
13-14	**Actuarial Mathematics:** Life assurance - Present values of various life assurances in terms of commutation functions. Premiums - Different types of premiums; net premiums; office premiums; premium series. Prospective policy values - Theory and practice of pension plan funding, assumptions, population theory applied to private pensions. Valuation theory for pension plans, expense function and dividends.	Classroom Lecture and Discussion	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Scott Besley and Eugene F. Brigham (2007). Essentials of Managerial Finance, 14th Edition. USA: Thomson, South-Western.
ii. Parmenter, M. M. (1999). Theory of Interest and Life Contingencies with Pension Application, 3rd Edition, ACTEX Publication, Winsted, CT, USA.
iii. Promislow, S. D., (2011). Fundamentals of actuarial mathematics, 2nd Edition. John Wiley & Sons.

Supplementary Readings:

i. James, C., Van H., John M. Wachowicz (2008). Fundamentals of financial management, 13th Edition. Pearsons Education.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0521-3105	Environmental Statistics	GED	3.00	100

1. Rationale of the Course:

This course is designed to address the critical intersection of environmental science and statistical analysis. Understanding and addressing environmental challenges is essential for sustainable development. This course equips students with the knowledge and skills to collect, analyze, and model environmental data, making informed decisions to mitigate environmental issues.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of Environmental Statistics and its applications. The specific objectives include:

- To provide students with a fundamental understanding of the environment, sustainable development, and global environmental challenges.
- To teach students how to collect environmental data from various sources and analyze it using statistical techniques, enabling them to assess conditions and trends.
- To equip students with the knowledge to identify pollutants, their sources, and their effects, and to explore methods for decomposing pollutants and assessing their dispersion in space and time.
- To introduce students to environmental and natural resource economics and enable them to inform decision-making.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students can increase awareness about the environment and the basic concepts of the environment.	3	2	2	1	2
2. Students can develop knowledge of pollutants by type, source, and their effects on the environment.	3	3	2	3	2
3. Students can develop knowledge of how to collect statistical data on various environmental elements.	2	3	3	2	2
4. Students can develop knowledge of statistical techniques to study the distribution of pollutants and natural resources.	1	2	3	3	2

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Basic Ideas on Environment:** Definition of the Environment and its Components. Concept of Sustainable Development, Indispensability, and Inseparability of Sustainable Development.	Classroom Lecture and Discussion	1

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
	Global Environmental Sustainability Challenges. Greenhouse Gases and Global Warming. Impacts of Greenhouse Gases. Concept of Ozone Layer Depletion and its Effects. Climate Change and Effects of Climate Change. Basics on Ecology and Ecosystem, Biodiversity. Concept of extremes in environment.		
2-3	**Environmental Indicators, Data Sources and Sampling:** Meteorological Data: Temperature, Rainfall, Flood, Humidity, Atmospheric Pressure. Water Level Data: Water Depth, Ground Water Level Data. Air Quality Data: Ambient Air Quality Standards. **Data Sources:** Secondary and Primary Sources. **Sampling:** Composite Sampling, Grab Sampling, Capture-Recapture Sampling.	Classroom Lecture and Discussion	1
4	**Pollutants:** Pollutants and Its Types, Sources of Pollutants, Effects of Pollutants, Methods of Decomposition of Pollutants: Aerobic and Anaerobic processes.	Classroom Lecture and Discussion	2
5-6	**Diffusion and Dispersion of Pollutants:** Concept of Diffusion and Dispersion of Pollutants, Distribution of Pollutants with Respect to Space and Time using Wedge Machine and Plume Model.	Classroom Lecture and Discussion	3, 4
7	**Dilution of Pollutants:** Deterministic Dilution, Stochastic Dilution, Theory of Successive Random Dilution (SRD), Application of SRD to Environmental Phenomena.	Classroom Lecture and Discussion	3, 4
8	**Water Quality:** Water Quality Parameters, Bangladesh Environmental Conservation Rules (2023). Water Quality Index using Matal Pollution, Biological Pollution, etc.	Classroom Lecture and Discussion	3, 4
9	**Air Quality:** Concept of Air Quality. Air Quality Parameters, Air Quality Index as per Ambient Air Quality Standards.	Classroom Lecture and Discussion	3, 4
10	**Soil Quality:** Concept of Soil Quality, Concentrations of Pollutants in Soils, Determination of Soil Quality: Ecological Risk of Heavy Matels in Soil, Contamination Factor, Degree of Contamination, Pollution Load Index, Potential Ecological Risk Index.	Classroom Lecture and Discussion	3, 4
11	**Mass Balance Equation:** Concept, use of Mass Balance Equation in studying the movement of substances, e.g., pollutants, within environmental compartments like water, air, and soil.	Classroom Lecture and Discussion	3,4

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
12	**Statistical Theory of Rollback:** Predicting Concentrations after Source Control, Previous Rollback Concepts, Environmental Transport Models in Air and Water.		3,4
13	**Environment and Potential Health Risk Determinants:** Basic Concept. Measurement of Potential Health Risk: Estimated Daily Intake, Carcinogenic Risk, target Hazard quotients.	Classroom Lecture and Discussion	3,4
14	**Environmental and Natural Resource Economics:** Resources, Environment and Economic Development. Population, Agriculture, Energy and Sustainable Development. Sustainable Management for Natural Resources. Valuing the Environment, Techniques of Valuation and Cost-Benefit Analysis.	Classroom Lecture and Discussion	3,4

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Barnett, V. (2004). Environmental Statistics: Methods and Applications, John Wiley and Sons, New York.
ii. Schnoor, J. L. (1996). Environmental Modeling: Fate and Transport of Pollutants in Water, Air and Soil, John Wiley & Sons, Inc., New York, USA.
iii. Clark, M. M. (1996). Transport Modeling for Environmental Engineers and Scientists, John Wiley & Sons, New Jersey, USA

Supplementary Readings:

i. Wayne, R. Ott (1995). Environmental Statistics and Data Analysis, Lewis Publishers, England.
ii. Barnet, V. and Turkman, K.F. (1993). *Statistics for the Environment*, Joh Willey and Sons, Chichester.
iii. Hill, M.K. (2012). *Understanding Environmental Pollutions*, 3rd Edition, Cambridge University Press, London.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-3106	LAB - Inference and Decision Making	LAB	1.0	100

1. Rationale of the Course:

This course is designed to solve some practical problems by using statistical tools that are learned in the theoretical courses by using computer programming and statistical software.

2. Course Objectives:

The major objectives of this course include:

- To analyze data using statistical tools that are learned in the course Advanced Statistical Inference .
- To make a scientific report based on practical problems.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. The student will gain practical knowledge about the complexity of data and analyze these data by using advanced statistical tools.	1	2	2	3	3
2. The student will learn how to make a scientific report based on statistical results.	1	3	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-3101: Advanced Statistical Inference".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1, 2

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-3107	LAB - Econometric Analysis	LAB	1.0	100

1. Rationale of the Course:

To learn real-world statistical applications in the field of econometrics using appropriate software.

2. Course Objectives:

The major objectives of this course include:

- To demonstrate practical problems of econometrics to quantify and verify predictions from economic theory with the applications of different statistical methodology.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to Learn how to estimate parameters in presence of errors in variables; test for the key assumptions of regression analysis viz. autocorrelation, multicollinearity, heteroscedasticity etc.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-3102: Econometrics".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-3108	LAB - Data Structure and Visualization using Python and R	LAB	1.0	100

1. Rationale of the Course:

This course is designed to equip students with the essential skills to efficiently manage and visualize complex data sets in Python and R, enabling them to analyze and present data effectively for various research and analytical purposes.

2. Course Objectives:

The major objectives of this course include:

- To familiarize students with the fundamental concepts of data organization, manipulation, and visualization in Python and R, facilitating their ability to handle and represent diverse datasets for analytical purposes.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will develop a comprehensive understanding of various data structures, along with the proficiency to implement efficient data management techniques and create effective visual representations of data using Python and R, enabling them to analyze and communicate complex information for diverse applications.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0610-3103: Data Structures and Visualization".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Year 3, Semester 2:

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-3201	Non-Linear and Flexible Regression Models	Elective	3.0	100

1. Rationale of the Course:

This course offers a critical exploration of advanced regression techniques, enabling students to model complex, non-linear relationships inherent in diverse datasets. By integrating nonlinear regression methods and flexible modeling techniques, students gain invaluable skills in handling intricate, real-world datasets. The course emphasizes mixed models, enabling the analysis of correlated data structures. This course fosters expertise in analyzing complex data structures, ensuring graduates are well-equipped for data-centric challenges in various professional domains.

2. Course Objectives:

This course is primarily designed to provide students with the fundamentals of robust statistics and applications. The specific objectives includes:

- To develop expertise in nonlinear regression methods, enabling accurate modeling of complex relationships in diverse datasets.
- To acquire skills in flexible modeling techniques to handle diverse data patterns and variations, ensuring adaptability to real-world complexities.
- To gain a deep understanding of mixed models, allowing the analysis of correlated data structures and enhancing the ability to account for complex data interactions.
- To apply advanced statistical tools to extract meaningful insights, empowering data-driven decision-making in various professional fields.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will apply nonlinear regression methods to model complex relationships within datasets, demonstrating proficiency in capturing nonlinear patterns.	3	2	2	2	2
2. Students will utilize flexible modeling techniques to accommodate diverse data patterns, showcasing the ability to adapt modeling strategies to different scenarios.	3	3	2	3	2
3. Students will implement mixed models analysis to handle correlated data structures.	2	3	3	2	2
4. Students will interpret statistical analyses and effectively communicate results, demonstrating the ability to convey complex findings.	1	2	3	3	2

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Introduction to Regression Analysis:** Review of linear regression and its limitations. Understanding the need for nonlinear regression models. Introduction to flexible regression techniques.	Classroom Lecture and Discussion	1
2-3	**Nonlinear Regression Models:** Polynomial regression: modeling nonlinear relationships using polynomial functions, Parameter estimation, interpretation and inference for the polynomial regression	Classroom Lecture and Discussion	1, 2
4	Nonlinear regression with exponential, logarithmic, and power functions. Intrinsically linear model.	Classroom Lecture and Discussion	1, 2
5	Splines and smoothing techniques for capturing complex patterns in data.	Classroom Lecture and Discussion	2
6	**Flexible Modeling Approaches:** Introduction to generalized additive models (GAMs).	Classroom Lecture and Discussion	2
7	Locally weighted scatterplot smoothing (LOWESS) for nonparametric regression.	Classroom Lecture and Discussion	2
8	**Tree-based Methods:** decision trees, random forests, and boosting algorithms for flexible modeling.	Classroom Lecture and Discussion	3, 4
9-10	**Mixed Models and Correlated Data Analysis:** Understanding mixed-effects models. Dealing with hierarchical and longitudinal data structures. Incorporating random effects to account for variability within groups.	Classroom Lecture and Discussion	3, 4
11-12	Analysis of repeated measures and clustered data. Hands-on exercises and coding sessions to reinforce theoretical concepts.	Classroom Lecture and Discussion	3, 4
13-14	**Model Selection and Validation:** Techniques for model selection, including cross-validation and information criteria (AIC, BIC). Assessing model goodness-of-fit and handling overfitting. Validation techniques for nonlinear and mixed models.	Classroom Lecture and Discussion	2, 3, 4

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examinations.
CLO-2		
CLO-3		
CLO-4		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Härdle, W. (2013). Applied Nonparametric Regression, Cambridge University Press.
ii. Ratkowsky, D. A. (1990). Handbook of Nonlinear Regression Models, M. Dekker.
iii. Mikis, D. S., Robert, A. R., Gillian, Z. H., Vlasios, V., and Fernanda, D. B. (2017). Flexible Regression and Smoothing Using GAMLSS in R, 1st Edition, Chapman and Hall/CRC.

Supplementary Readings:

i. Wood, S. N. (2017). Generalized Additive Models: An Introduction with R. 2bd Edition, Chapman and Hall/CRC.
ii. Green, P. J., and Silverman, B. W. (1993). Nonparametric regression and generalized linear models: a roughness penalty approach. CRC Press.
iii. Fitzmaurice, G. M., Laird, N. M., and Ware, J. H. (2011). Applied Longitudinal Analysis. Wiley.
iv. Pinheiro, J. C., and Bates, D. M. (2000). Mixed-Effects Models in S and S-PLUS. Springer.

Course Code: 0542-3202	Course Title: Statistical Simulation and Modelling	Course Type: Core	Credit Value: 3.0	Total Marks: 100

1. Rationale of the Course:

This course is designed to provide students with a comprehensive understanding of statistical simulation techniques and their practical applications. This course covers a broad range of topics, from the basics of simulation processes and Monte Carlo methods to advanced techniques in variance reduction, generation of random variables, and empirical testing of random number generators. This course will provide the student with a hands-on introduction to this fascinating and useful subject.

2. Course Objectives:

The objective of this course includes:

- To understand a broad spectrum of advanced methods in Monte Carlo simulation, with emphasis on both practical exercises and theory.
- To learn Monte Carlo methods, collectively one of the important analytical tools of modern statistical inference.
- To introduce the techniques of generating the uniform random variable and empirical testing of uniform random number generators.
- To introduce non-uniform random variable generating techniques, variance reduction techniques, and different statistical analysis techniques of simulated data.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will be able to gain a thorough understanding of simulation along with Monte Carlo methods.	3	2	2	1	2
2. Students will be able to develop skills in applying variance reduction techniques like stratified sampling and conditional Monte Carlo.	3	3	2	3	2
3. Students will be able to learn to generate uniform and non-uniform random variables using various methods.	2	3	3	2	2
4. Students will be able to acquire proficiency in empirical testing of random number generators through tests like Chi-Square and Kolmogorov-Smirnov.	1	3	2	3	3
5. Students will be able to become adept at analyzing simulated data, including parameter estimation and model comparison using simulation techniques.	1	1	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-2	**Overview:** Meaning, Motivational Example, Simulation Process, Verification, Validation, Synchronous and Asynchronous Discrete Event Simulation, Continuous Event Simulation, Hybrid Event Simulation, Monte Carlo: Hit or Miss Monte Carlo Method, Sample-Mean Monte Carlo Method.	Classroom Lecture and Discussion	1
3-4	**Variance Reduction Technique:** Stratified Sampling, Conditional Monte Carlo, Jackknifing, Antithetic Variates.	Classroom Lecture and Discussion	1, 2
5-7	**Generating Uniform Random Variable:** Classes of Generators – Random Devices, Tables, Mid-square Method, Fibonacci and Additive Congruential Generators, Linear Congruential Generators, Linear Recursion Mod 2 Generator, Combinations of Generators, Choosing Good Generator Based on Theoretical Considerations, Serial Correlation, Cycle of Length, Spectral Test.	Classroom Lecture and Discussion	3
8-9	**Empirical Testing of Uniform Random Number Generators:** Chi-Square Test, Kolmogorov-Smirnov Test, Gap Test, Run Test, Poker Test, Test of Autocorrelation, Maximum Test.	Classroom Lecture and Discussion	3, 4
10	**Generating Non-Uniform Random Variables:** Alias Method, Inverse Transformation Method, Acceptance-Rejection Method, Polar Method.	Classroom Lecture and Discussion	3
11	Method of Generating Random Numbers from Normal, Exponential, Gamma, Beta, χ^2, t, F, Cauchy, Binomial, Poisson, Geometric, Negative Binomial Distributions.		3
12-14	**Statistical Analysis of Simulated Data:** Checking Properties of BLUE, Estimating Parameters of Linear Regression and Non-linear Regression Model, Interval Estimates of Population Mean. Models comparison using simulation.	Classroom Lecture and Discussion	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Law, M. A. (2024). Simulation Modeling and Analysis, 6th Edition, McGraw-Hill.
ii. Ross, S. M. (2022). Simulation, 6th Edition, Academic Press, USA.

Supplementary Readings:

i. Afifi, A. A. and Azen, S. P. (1979). Statistical Analysis: A Computer Oriented Approach, 2nd Edition, Academic Press, New York.
ii. Bartley, P., Fox, B. L. and Schrage, L. E. (1987). A Guide to Simulation, 2nd Edition, Springer-Verlag, New York.

Course Code:	Course Title:	Course Type:	Credit Value: 3.0	Total Marks:
0610-3203	Data Mining	Elective		100

1. Rationale of the Course:

The Data Mining course is designed to provide students with a deep understanding of data mining concepts and techniques, essential in today's data-driven world. This course covers a wide range of topics, from the fundamentals of data mining and knowledge discovery to advanced techniques. The course is vital for students aiming to pursue careers in data analysis, business intelligence, and machine learning, as it combines theoretical knowledge with practical applications.

2. Course Objectives:

The specifics of this course include:

- To understand the basics of data mining, including data mining tasks, and the difference between supervised and unsupervised learning.
- To master the concepts of fuzzy sets and fuzzy relations, including their properties, operations, and applications.
- To gain proficiency in machine learning algorithms such as Naïve Bayes, genetic algorithms, neural networks, and Support Vector Machines.
- To learn advanced data mining methods like decision tree and classification, clustering, association rules, text mining, and web mining.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will develop a comprehensive understanding of data mining, including knowledge discovery.	3	2	2	1	2
2. Students will acquire skills in applying fuzzy set theory and fuzzy logic in data analysis, understanding the fundamentals and complex operations.	3	3	2	3	2
3. Students will become proficient in applying various machine learning algorithms, including Naïve Bayes, genetic algorithms, and neural networks, in practical scenarios.	2	3	3	2	3
4. Students will gain expertise in decision tree-based algorithms and classification methods, understanding their practical applications in data analysis.	3	2	3	3	3
5. Students will master clustering techniques and association rules, developing the ability to discover patterns and relationships in large datasets.	1	3	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Related Concepts of Data Mining:** Meaning of Data Mining and Knowledge Discovery, Basics, Data Mining Tasks, Supervised & Unsupervised Learning, Classification & Regression.	Classroom Lecture and Discussion	1
2	**Fuzzy Set:** Concept, Classical Set, Set Operation, Boolean Logic, Basic Concepts and Representations of Fuzzy Sets. Determination of Membership Functions, Properties and Operations of Fuzzy Sets.	Classroom Lecture and Discussion	2
3	**Fuzzy Relation:** Classical Relations and Reasoning, Fuzzy Relations and its Types, Operations on Binary Fuzzy Relations, Fuzzy Reasoning. Database/OLTP Systems, Logic, Information Retrieval, Decision Support Systems, Dimensional Modeling, Multidimensional Schemas, Indexing, Data Warehousing, OLAP, Web Search Engines, Machine Learning, Pattern Matching.	Classroom Lecture and Discussion	2
4-5	**Naïve Bayes Classification & Genetic Algorithms:** Supervised Learning, Naive Bayes Algorithm, Bayes Theorem, Naive Bayes Classification, Multinomial Naïve Bayes Classification. Genetic Algorithms, Fitness function, selection, crossover, mutation.	Classroom Lecture and Discussion	3
6	**Neural Network:** Basic Neuron Model, Perception, Multiplayer Perception, Recurrent Network, Hopfield Network, Boltzmann Machine Network, Kohonen Self-Organizing Network, Determining the Winning Neuron, Learning Algorithm, Neural Network-based Algorithms, Propagation, NN, Supervised Learning, Radial Basis Function Network, Perceptrons.	Classroom Lecture and Discussion	4
7	**Decision tree & Classification:** Concept, Statistical-based Algorithms, Regression, Bayesian Classification, Distance-based Algorithms, K-Nearest Neighbors, Decision Tree-based Algorithms, Rule-based Algorithms, Generating Rules from DT, Generating Rules from Neural Net.	Classroom Lecture and Discussion	4
8	**Support Vector Machine:** Maxima/Margin Classifier; Support Vector Classifiers; Support Vector Machines; SVMs with More than Two Classes; Relationship to Logistic Regression	Classroom Lecture and Discussion	4
9	**Clustering:** Hierarchical and Non-Hierarchical Clustering, Clustering PAM Algorithm, Clustering with Genetic Algorithms, Clustering with Neural	Classroom Lecture and Discussion	4

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
	Networks, Clustering Large Databases, Clustering with Categorical Attributes.		
10	**Association Rules:** Meaning of Association, Large Item Sets, Basic Algorithms, Apriori Algorithm, Sampling Algorithm, Partitioning, Parallel and Distributed Algorithms, Data Parallelism, Task Parallelism, Advanced Association Rules, Quantitative Association Rules, Measuring Quality of Rules.	Classroom Lecture and Discussion	5
11-12	**Text Mining:** Introduction and overview of quantitative text analysis and its applications. Information extraction, Basics of Text Mining, Common Text Mining Visualizations, Sentiment Scoring, Hidden Structures, Topic Modeling.	Classroom Lecture and Discussion	5
13-14	**Web Mining:** Web Content Mining, Crawlers, Harvest System, Virtual Web View, Personalization, Web Structure Mining, Page Rank, Clever, Web Usage Mining, Preprocessing, Data Structures, Pattern Discovery & Analysis.	Classroom Lecture and Discussion	5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Dunham, M. H. (2020). Data Mining: Introductory and Advanced Topics, 1st Edition, Pearson.

Supplementary Readings:

i. Larose, D. T. (2006). Data Mining: Methods and Models, Wiley-Interscience, India.
ii. Aggarwal, C. C. (2015). Data mining: the textbook. New York: springer.
iii. Schalkoff, R. (2005). Pattern Recognition Statistical, Structural and Neural Approaches, John Wiley and Sons, New York.
iv. Han, J., Kamber, M. and Pei, J. (2022). Data mining concepts and techniques, 4th edition, Morgan Kaufmann.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-3204	Biostatistics and Survival Analysis	Core	3.0	100

1. Rationale of the Course:

This course is designed to provide students with a solid foundation in the statistical methods and concepts used in biomedical research. This course emphasizes the understanding and application of various statistical techniques crucial for analyzing and interpreting biological and health-related data. This comprehensive approach is essential for students pursuing careers in biostatistics, epidemiology, public health, and clinical research, as it equips them with the necessary skills to conduct rigorous statistical analyses in these fields.

2. Course Objectives:

The objective of this course include:

- To gain a thorough understanding of fundamental concepts like probability density, survival, and hazard functions and their interrelationships.
- To understand censoring and truncation in survival data and to learn survival likelihood estimation for censored data.
- To develop skills in non-parametric estimation of survival functions using methods like the Life Table and Kaplan-Meier estimation.
- To learn about proportional hazard regression and exponential regression models, including their estimation and hypothesis testing.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will develop proficiency in understanding and applying basic biostatistical concepts such as probability density, survival, and hazard functions.	3	2	2	1	1
2. Students will acquire skills in analyzing censored data and applying likelihood functions.	3	3	2	3	2
3. Students will gain expertise in non-parametric estimation of survival functions, including methods.	2	3	3	2	2
4. Students will be able to use methods for comparing survival distributions.	1	3	3	3	2
5. Students will develop competence in understanding and applying proportional hazard and exponential regression models, including hypothesis testing in these models.	1	3	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Basic Concept:** Probability Density Function, Survival Function, Hazard Function and their interrelationships.	Classroom Lecture and Discussion	1
2	**Censoring and Truncation:** Type I, Type II, and Random Censoring; Likelihood Functions under Different Types of Censoring.	Classroom Lecture and Discussion	2
3-4	**Survival Likelihood:** Exponential, Weibull, Extreme Value, Gamma, Lognormal and Log-Logistic for censored data	Classroom Lecture and Discussion	2
5	**Non-Parametric Estimation of Survival Functions:** Life Table Method, Product Limit Method (Kaplan-Meier estimation), Variance Estimates, Cumulative Hazard Function, Plots Involving Estimated Survival and Hazard Functions.	Classroom Lecture and Discussion	3
6	**Methods for Comparing Survival Distributions:** Comparing two groups of survival times, Gehan's Generalized Wilcoxon Test, Mantel-Haenszel Test.	Classroom Lecture and Discussion	4
7-8	**Proportional Hazards Regression:** Concept & assumption of proportional hazards (PH) regression model, estimation of the coefficient of PH model, partial likelihood with tied observations, testing hypothesis in semi-parametric model.	Classroom Lecture and Discussion	4
9-10	**Inference Procedures for Exponential Distributions:** One Parameter Exponential Distribution with Type I and Type II Censored Data, Comparison of Exponential Distributions. Two Parameter Exponential Distribution with Type I and Type II Censored Data.	Classroom Lecture and Discussion	5
11-13	**Concept and Inference Procedures for Extreme Value Distributions:** Concept of extremes in Biostatistics. Extreme Value distribution, Limiting distribution of Extreme value distribution. Inference Procedures for Weibull and Extreme Value Distributions with Type I and Type II Censored Data.	Classroom Lecture and Discussion	5
14	**Parametric Regression Model:** Methods of Estimation and Tests of Hypothesis for Exponential Regression model, Weibull Regression model and Frailty models	Classroom Lecture and Discussion	5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Lee, E. T. and Wang, J. W. (2013): Statistical Methods for Survival Data Analysis, 4th Edition, Wiley Series, New York.
ii. Lawless, J. F. (2011). Statistical models and methods for lifetime data. John Wiley & Sons.
iii. Hosmer Jr, D. W., Lemeshow, S., & May, S. (2008). Applied survival analysis: regression modeling of time-to-event data, John Wiley & Sons.

Supplementary Readings:

i. David, G. K., & Mitchel, K. (2012). Survival analysis: a Self-Learning text. Springer
ii. O'Quigley, J. (2021). Survival Analysis: Proportional and Non-Proportional Hazards Regression, Springer International Publishing.
iii. Barker, D. J. P. and Hall, A. J. (1991). Practical Epidemiology, 4th Edition, Churchill Living Stone, Edinburg.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-3205	LAB - Data Processing using SPSS and STATA	LAB	2.0	100

1. Rationale of the Course:

This course is designed to provide students with comprehensive training in utilizing SPSS and STATA for data manipulation and analysis, fostering a thorough understanding of these powerful statistical software tools commonly employed in various research and analytical domains.

2. Course Objectives:

The major objectives of this course include:

- To equip students with the necessary skills to proficiently manage, process, and analyze large datasets using the SPSS and STATA software, enabling them to derive accurate insights and conclusions for research and analytical purposes.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to the proficiency to effectively utilize SPSS and STATA to clean, process, and analyze complex datasets, enabling them to generate meaningful statistical outputs, interpret results, and communicate data-driven insights for diverse research and analytical applications.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-4	**Data Processing and Statistical Software:** Understanding the role of data in decision-making; Introduction to SPSS and STATA interfaces; Data types and data import/export	Computer intensive program	1
5-8	**Data Cleaning and Preparation:** Data validation and cleaning techniques; Missing data handling; Data transformation and recoding	Computer intensive program	1
9-10	**Descriptive Statistics:** Measures of central tendency (mean, median, mode, weighted mean, trimmed mean) and dispersion (absolute and relative measures of dispersion); Frequency	Computer intensive program	1

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
	distributions and graphs; Data visualization with SPSS and STATA		
11-12	**Inferential Statistics:** Hypothesis testing (t-tests-test, F-test, ANOVA); Correlation and regression analysis; non-parametric tests	Computer intensive program	1
13-14	**Data Interpretation and Reporting:** Interpreting results and drawing conclusions; Effective data visualization and reporting; Ethical considerations in data analysis **Real-World Applications:** Applying data analysis skills to research projects; Case studies and practical exercises; project presentations and peer reviews	Computer intensive program	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Andy, F. (2017). Discovering Statistics Using IBM SPSS, 4th Edition, SAGE Publications Ltd.
ii. Michael, N. M. (2020). Data Management Using Stata: A Practical Handbook, 2nd Edition, Stata Press.

Supplementary Readings:

i. Daniels, L. & Nicholas, W. M. (2019). An Introduction to Statistics and Data Analysis Using Stata, SAGE Publications, Inc.
ii. Landau, S. (2003). A Handbook of Statistical Analyses Using SPSS, 1st Edition, Routledge.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-3206	LAB - Application of Flexible Regression Models	LAB	1.0	100

1. Rationale of the Course:

This course is designed to provide students with the necessary knowledge and skills to apply advanced regression techniques, enabling them to analyze complex relationships within data and make more accurate predictions for various practical and research-based applications.

2. Course Objectives:

The major objectives of this course include:

- To equip students with the theoretical foundation and practical expertise to effectively apply and interpret a range of flexible regression models, enabling them to handle complex data and make robust predictions in diverse research and practical contexts.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to acquire the ability to employ and evaluate various flexible regression techniques.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-3201: Non-linear and Flexible Regression Models".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-3207	LAB - Simulation using Python and R	LAB	1.0	100

1. Rationale of the Course:

This course aims to provide students with practical experience in creating and analyzing simulated models, fostering a comprehensive understanding of the application of simulation techniques in diverse fields for decision-making, analysis, and problem-solving purposes.

2. Course Objectives:

The major objectives of this course include:

- To enable students to develop a deep understanding of simulation methodologies and gain practical skills in implementing simulation models using Python and R.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to design, implement, and evaluate simulation models, enabling them to analyze complex systems, make informed predictions, and recommend effective strategies for decision-making and problem-solving in various practical and research contexts.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-3202: Statistical Simulation and Modelling".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-3208	LAB - Application of Data Mining Techniques	LAB	1.0	100

1. Rationale of the Course:

To learn the real-world statistical applications with data mining techniques using relevant software.

2. Course Objectives:

The major objectives of this course include:

- To equip students with the theoretical knowledge and practical skills necessary to apply advanced data mining techniques, enabling them to extract valuable patterns and insights from complex datasets for informed decision-making and predictive analysis in various domains.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will be able to proficiently utilize a range of data mining techniques to identify significant patterns, trends, and correlations within large datasets	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0610-3203: Data Mining".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-3209	LAB - Analysis of Time to Event Data	LAB	1.0	100

1. Rationale of the Course:

This course is designed to equip students with practical skills in analyzing and interpreting time-to-event data, facilitating a comprehensive understanding of survival analysis techniques and their applications in various research and practical contexts.

2. Course Objectives:

The major objectives of this course include:

- To enable students to comprehend the principles of survival analysis, and acquire proficiency in utilizing relevant statistical methods and software tools.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be capable to apply a range of survival analysis techniques, interpret survival curves, assess risk factors, and effectively communicate insights derived from time-to-event data analysis, thus enabling them to make informed decisions and recommendations in various research and practical applications.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per theoretical course "0542-3204: Biostatistics and Survival Analysis".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Year 4, Semester 1:

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4101	Bayesian Inference	Elective	3.00	100

1. Rationale of the Course:

The Bayesian Inference course provides a comprehensive introduction to Bayesian statistical methods. It emphasizes both the theoretical foundations and practical applications of Bayesian inference, making it highly relevant for students pursuing careers in statistics, data science, and related fields. The course's focus on numerical techniques, choice of priors, and Bayesian computational methods ensures that students are well-prepared to apply these concepts in various research and analytical contexts.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of Bayesian Inference and its applications. The specific objectives include:

- To gain a foundational understanding of Bayesian inference, including Bayes theorem and summarizing posterior distributions.
- To learn about posterior summary measures, predictive distributions, and making inferences using credible intervals.
- To understand the principles of Bayesian hypothesis testing, including the comparison with frequentist methods.
- To delve into advanced topics such as sampling from posterior distributions, choosing prior distributions, and Markov chain Monte Carlo sampling.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will gain a deep knowledge about fundamental tools for statistical inference using Bayesian approach.	3	2	2	1	1
2. Students will be proficient in posterior summary measures, understanding and applying predictive distributions and credible intervals.	3	3	2	3	2
3. Students will acquire skills in conducting Bayesian hypothesis tests, understanding Bayes factors, and comparing Bayesian and frequentist approaches.	2	3	3	2	3
4. Students will understand joint versus marginal posterior inference and the frequentist properties of Bayesian inference.	1	2	3	3	3
5. Students will gain expertise in Bayesian computational techniques.	1	2	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-2	**Introduction to Bayesian inference:** Basic Concept, Bayes theorem (continuous and categorical version), the different modes of the Bayesian approach, summarizing the posterior by probabilities.	Classroom Lecture and Discussion	1
3-4	Posterior summary measure, predictive distribution, exchangeability, a normal approximation to the posterior, numerical techniques to determine the posterior (numerical integration, sampling from the posterior, choice of posterior summary measure).	Classroom Lecture and Discussion	2
5-6	**Credible interval**: Inference based on credible intervals for proportion, mean, variance, correlation, regression coefficients.	Classroom Lecture and Discussion	2
7-8	**Bayesian hypothesis testing:** the Bayes factor, Bayesian versus frequentist hypothesis testing for proportion, mean, variance, correlation, regression coefficients.	Classroom Lecture and Discussion	3
9	**More than one parameter:** Joint versus marginal posterior inference, multivariate distributions, frequentist properties of Bayesian inference.	Classroom Lecture and Discussion	3
10	**Sampling from the posterior distribution:** the method of composition, Bayesian linear regression model.	Classroom Lecture and Discussion	3, 4
11-12	**Choosing the prior distribution:** the sequential use of Bayes theorem, conjugate prior, Jeffrey's Prior, non-informative prior distribution, informative prior distributions, prior distribution for regression models, modelling priors, other regression models.	Classroom Lecture and Discussion	3, 4
13-14	**Markov chain Monte Carlo sampling:** the Gibbs sampler, the Metropolis (-Hastings) algorithm, justification of the MCMC approach, choice of the sampler, the Reversible Jump MCMC algorithm, Assessing and improving convergence of the Markov chain, accelerating convergence.	Classroom Lecture and Discussion	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Gelman, A., Carlin, J. B., Stern, H. S., & Rubin, D. B. (2013). Bayesian data analysis. 3rd Edition, Chapman and Hall/CRC.
ii. Winkler, R. L. (2003). An introduction to Bayesian inference and decision. 2nd Edition, Probabilistic Publication.

Supplementary Readings:

i. Heard, N. (2021). An introduction to Bayesian inference, methods and computation. Cham: Springer.
ii. Lesaffre, E. and Lawson, A. B. (2014). Bayesian Biostatistics, John Wiley and Sons Inc., New York.
iii. O' Hagan, A. and Forster, J. (2004). Advanced Theory of Statistics, Bayesian Inferences, Vol. 2B, Arnold, London.
iv. Stuart A. and Ord. Keith, J. (1986). Advanced Theory of Statistics, Vol. II, 5th Edition, Charles Griffin and Company Ltd., London.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-4102	Machine Learning	Elective	3.0	100

1. Rationale of the Course:

This course provides a comprehensive understanding of the fundamental concepts and advanced techniques in machine learning and statistical modeling. Through a blend of theoretical knowledge and hands-on practical exercises, students learn to develop predictive models, optimize algorithms, and validate results. The course emphasizes the importance of statistical methods in enhancing machine learning algorithms, ensuring students grasp the theoretical underpinnings while gaining practical problem-solving experience.

2. Course Objectives:

This course is primarily designed to provide students with the application of machine learning techniques and applications. The specific objectives include:

- To understand the basics of statistical learning, including supervised and unsupervised learning, regression and classification problems, and the concept of model accuracy.
- To learn about linear regression in statistical learning, and to understand classification methods like logistic regression and discriminant analysis.
- To gain knowledge of resampling techniques such as cross-validation and bootstrap, and to learn about model selection in statistical learning.
- To delve into tree-based models and unsupervised learning techniques, including decision trees, random forests, boosting algorithms, and principal components analysis.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will understand the core concepts and mathematical foundations of statistical learning algorithms.	3	2	2	2	2
2. Students will gain proficiency in applying linear regression techniques and classification methods, understanding their practical implications and comparisons.	3	3	2	3	3
3. Students will acquire skills in resampling techniques like k-fold cross-validation and regularization methods like ridge regression and lasso.	2	3	3	3	2
4. Students will become competent in tree-based models, understanding the basics of decision trees, regression trees.	1	2	3	3	3
5. Students will gain expertise in unsupervised learning methods, including principal components analysis and clustering techniques, applying them to various datasets.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**An Introduction to Statistics for Machine Learning:** What Is Statistical Learning; Supervised Versus Unsupervised Learning; Regression Versus Classification Problems; Assessing Model Accuracy; Measuring the Quality of Fit; The Bias-Variance Trade-Off; The Classification Setting.	Classroom Lecture and Discussion	1
2-3	**Statistical Learning of Linear Regression:** Assessing the Accuracy of the Model; Multiple Linear Regression; Qualitative Predictors; Extensions of the Linear Model; Potential Problems; The Marketing Plan; Comparison of Linear Regression with K-Nearest Neighbors.	Classroom Lecture and Discussion	1, 2
4-5	**Statistical Learning of Classification:** An Overview of Classification; The Logistic Model; Making Predictions; Multiple Logistic Regression; Linear Discriminant Analysis; Quadratic Discriminant Analysis; A Comparison of Classification Methods.	Classroom Lecture and Discussion	3
6-7	**Statistical Learning from Re-sampling:** Cross-Validation; The Validation Set Approach; Leave-One-Out Cross-Validation; k-Fold Cross-Validation; Bias-Variance Trade-Off for k-Fold; Cross-Validation; Cross-Validation on Classification Problems; The Bootstrap.	Classroom Lecture and Discussion	3, 4
8-9	**Model Selection and Regularization:** Hyperparameter tuning, Subset Selection; Shrinkage Methods; Ridge Regression; The Lasso; Dimension Reduction Methods; Considerations in High Dimensions; High-Dimensional Data; Regression in High Dimensions; Interpreting Results in High Dimensions.	Classroom Lecture and Discussion	4
10-11	**Statistical Learning of Tree-based Models:** The Basics of Decision Trees; Regression Trees; Classification Trees; Trees Versus Linear Models; Advantages and Disadvantages of Trees; Bagging, Random Forests, boosting; Bagging; Random Forests; Boosting.	Classroom Lecture and Discussion	4, 5

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
12-13	**Boosting Algorithm:** AdaBoost, Gradient, and XG Boosting algorithm.	Classroom Lecture and Discussion	3, 4
14	**Statistical Unsupervised Learning:** The Challenge of Unsupervised Learning; Principal Components Analysis; Clustering Methods; K-Means Clustering; Hierarchical Clustering; Practical Issues in Clustering.	Classroom Lecture and Discussion	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. James, G., Witten, D., Hastie, T. and Tibshirani, R. (2021). An Introduction to Statistical Learning with Applications in R. 2nd Edition, New York: Springer.

Supplementary Readings:

i. Murphy, K. P. (2023). Probabilistic machine learning: Advanced topics. MIT press.
ii. Alpaydin, E. (2020). Introduction to machine learning. MIT press.
iii. Hastie, T., Tibshirani, R. and Friedman, J. (2009). The Elements of Statistical Learning: Data Mining, Inference, and Prediction. 2nd Edition, New York: Springer.
iv. Boehmke, B., and Greenwell, B. M. (2019). Hands-on machine learning with R. Chapman and Hall/CRC.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4103	Design and Analysis of Experiments	Core	3.00	100

1. Rationale of the Course:

In agriculture, livestock clinical industry, physical science, social and engineering science research data need to be collected and analyzed to test the significance regarding the impact factor involved in the experiment. This course covers the methodological and practical uses to design and analysis of experiments.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of probability theory and its applications. The specific objectives include:

- To understand basic concepts of experiment design.
- To understand the importance and benefits of it in different fields.
- To teach the students how to make the hypothesis.
- To explore the method of analysis of experimental data and set up the ANOVA table.
- To handle the missing value of the design of the experiment.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to know the basic principles of experimental design.	3	2	2	1	3
2. Students should be able to set up the models used in different experimental designs.	3	3	2	3	3
3. Students should be able to perform an analysis of variance on any experimental design.	2	3	3	2	3
4. Students should be able to test different hypothesis of the experiment and comments about different factors of the experiment.	1	2	3	3	3
5. Students should find out the efficiency of the design compared to others.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-2	**Design of experiment:** Basic concept of design of experiment, Principle of design, basic principle of experimental design, guideline/layout plan for designing experiment.	Classroom Lecture and Discussion	1
3	**CRD & RBD:** Concept of Completely Randomized Design (CRD), Randomized Block Design (RBD), layout plan for CRD & RBD, fixed factor, random factor.	Classroom Lecture and Discussion	1

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
4-5	**Concept of ANOVA:** Analysis of variance, Linear models for one-way ANOVA with single and several observations per cell, Assumption of model, One-way ANOVA table, several mean test, ANOVA for CRD data, estimation and test of hypothesis.	Classroom Lecture and Discussion	2
6	**Two-way ANOVA:** Two-way classification with single and several observations per cell, ANOVA for RBD data, estimation, and test of hypothesis.	Classroom Lecture and Discussion	1, 2
7-8	**Multiple comparison test:** Fisher's Least Significant Difference (LSD) Test, Tukey Method, Bonferroni Correction, Scheffe's Method, Dunnett's Test.	Classroom Lecture and Discussion	3, 5
9	**Variance component analysis:** Variance component analysis in one way, and two-way classified data.	Classroom Lecture and Discussion	3, 5
11-12	**Multi-way classification:** Analysis of variance for multi-way classification with single and several observations per cell, Perform ANOVA using software.	Classroom Lecture and Discussion	3, 4, 5
13-14	**LSD and Orthogonal Designs:** Latin Square Design (LSD). Efficiency of designs orthogonality and non-orthogonality of designs. Missing data in randomized block design and Latin square design and their analysis.	Classroom Lecture and Discussion	4,5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1 to CLO-5	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Montgomery, D. C. (2020): Design and Analysis of Experiments, 10th Edition, John Wiley and Sons, New York.

Supplementary Readings:

i. Bhuyan, K.C., (2017). Design of Experiments and Sampling Method. New Central Book Agency (P) Ltd. New Delhi, India.
ii. Das, M. N and Giri, N.C. (2003). Experimental Design. Theory and Application. Oxford and IBH New Delhi.
iii. Lawson, J. (2014). Design and Analysis of Experiments with R. CRC press, New York.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0912-4104	Epidemiology	GED	3.00	100

1. Rationale of the Course:

This course offers an in-depth exploration of the principles and practices of epidemiology, the cornerstone of public health research. Students will also learn about data collection, ethics, and data quality in epidemiological research. This course is essential for those aspiring to work in public health, research, or any field where understanding disease patterns and health determinants is crucial. It provides the foundational knowledge necessary to conduct meaningful epidemiological studies and contribute to public health policy and practice.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of Epidemiological issues. The specific objectives include:

- To grasp the fundamental concepts of epidemiology, including different epidemiological study designs and their strengths and weaknesses.
- To understand and calculate various measures of disease frequency like incidence, prevalence, and mortality rates.
- To learn how to identify risk factors in epidemiological studies and understand the concepts of causation and association.
- To gain knowledge in conducting epidemiological investigations, outbreak monitoring, and understanding the principles of screening and diagnostic tests.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will develop a comprehensive understanding of the definition, scope, and uses of epidemiology, and causation in disease epidemiology.	3	2	2	1	1
2. Students will become proficient in understanding and selecting appropriate epidemiological study designs for different research questions.	3	3	2	3	3
3. Students will acquire skills in measuring disease frequency, including incidence, prevalence, and mortality measures.	2	3	3	2	3
4. Students will gain competence in identifying risk factors and understanding the relationship between relative risk, attributable risk, and odds ratio.	2	3	3	2	3
5. Students will develop expertise in conducting outbreak investigations, monitoring disease outbreaks, and evaluating screening and diagnostic tests.	1	2	1	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Basic Concepts:** Definition, Scopes and Uses of Epidemiology, Causation in disease Epidemiology.	Classroom Lecture and Discussion	1
2-4	**Epidemiological Study Designs:** Introduction to study designs (cross-sectional, case-control, cohort). Retrospective and Prospective, Clinical Trials, Community Intervention and Cluster Randomized Trials. Strengths and weaknesses of each study design, selection of appropriate study designs for different research questions.	Classroom Lecture and Discussion	2
5-7	**Measures of Disease Frequency:** Incidence and Prevalence Rates, Relation between Incidence and Prevalence, Case Fatality Rate, Risk Ratio, Rate Ratio, Risk Difference, Rate Difference, Mortality Measures, Standardized Mortality Ratio; Modelling the variability of diseases with the Exponential distribution.	Classroom Lecture and Discussion	3
8-9	**Risk Factors and Causation:** Identifying risk factors in epidemiology, concepts of causation and association. Relative Risk, Attributable Risk, Odds Ratio.	Classroom Lecture and Discussion	4
10	**Outbreak Investigation:** Outbreak Investigation, Steps in Outbreak Investigation. Monitoring of disease outbreaks. Use of laboratory data in epidemiology.	Classroom Lecture and Discussion	5
11-12	**Screening and Diagnostic Tests:** Principles of screening. Sensitivity, Specificity, Negative and Positive Predictive Values. ROC curve.	Classroom Lecture and Discussion	5
13-14	**Data Collection and Sources:** Data sources in epidemiology (Surveys, Surveillance systems, Registries, Healthcare records). Epidemiological data sources in Bangladesh. Data collection methods, Ethics in Data Collection and Challenges. Data Quality and Validity Measures.	Classroom Lecture and Discussion	5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Schneider, M. J. (2020). Introduction to Public Health, 6th Edition, Jones & Bartlett Learning.

ii. Christiansen-Lindquist, L., and Wall, K. M. (2024). Fundamentals of Epidemiology. Springer Publishing Company.

Supplementary Readings:

i. Detels, Roger, et al. (2022). The Oxford Textbook of Global Public Health, 7th Edition, Oxford University Press. ii. Gordis, L. (2014). Epidemiology, 5th Edition, Elsevier Inc., Canada

iii. Merrill, R. M. (2013). Fundamentals of epidemiology and biostatistics: Combining the basics. Jones & Bartlett Publishers.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4105	Order Statistics and Non-Parametric Approaches	Elective	3.00	100

1. Rationale of the Course:

As implied by the name, nonparametric statistics are not based on the parameters of the normal curve. Therefore, if your data violate the assumptions of a usual parametric and nonparametric statistics might better define the data, try running the nonparametric equivalent of the parametric test. Though nonparametric statistical tests have more flexibility than do parametric statistical tests, nonparametric tests are not as robust; therefore, most statisticians recommend that when appropriate, parametric statistics are preferred.

2. Course Objectives:

The specific objectives of this course include:

- To study the theory of order statistics and non-parametric statistics.
- To introduce the extreme value theory and to make a link between the theory of order statistics and the theory of extreme value analysis.
- To introduce the problems of a parametric test when the parametric assumptions do not satisfy.
- To perform the nonparametric test(s) when parametric assumptions do not satisfy.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will grasp the concept of order statistics and be able to explain the role and significance of order statistics in statistical analysis.	3	2	2	1	1
2. Students will acquire the skills to calculate various order statistics, such as the sample minimum, maximum, and percentiles, and understand their practical applications.	3	3	2	3	2
3. Students will be able to analyze and interpret data involving the extremes of a sample, making inferences about extreme values, reliability, and risk assessment.	2	3	3	2	2
4. Students will gain a solid understanding of non-parametric statistical methods and their applicability in situations where parametric assumptions are violated.	1	2	3	3	3
5. Students will apply the value of non-parametric tests in cases where data do not meet parametric assumptions and be able to communicate the benefits of non-parametric methods.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Introduction to Order Statistics:** Definition and basic concepts, Notation and terminology, Motivation, and applications in statistics	Classroom Lecture and Discussion	1
2-3	**Basic Properties of Order Statistics:** Probability density functions (pdf) and cumulative distribution functions (cdf) of order statistics, Moments and moments-generating functions, Joint distribution of order statistics	Classroom Lecture and Discussion	1, 2
4	**Order Statistics Sampling:** Distribution of sample extrema, Distribution of sample range, Distribution of spacings	Classroom Lecture and Discussion	1, 3
4-6	**Inference for Order Statistics:** Maximum likelihood estimation for order statistics, Hypothesis testing involving order statistics, Confidence intervals for extreme values	Classroom Lecture and Discussion	1, 2
7	**Advanced Topics in Order Statistics**: Record values and record statistics, Records in continuous-time process, Nonparametric methods using order statistics	Classroom Lecture and Discussion	2
8	**Introduction to Nonparametric Statistics:** Overview of parametric vs. nonparametric statistics, Advantages and limitations of nonparametric methods, Situations where nonparametric tests are appropriate	Classroom Lecture and Discussion	3
9-10	**Rank-Based Tests:** Mann-Whitney U test, Wilcoxon signed-rank test, Kruskal-Wallis test, Friedman test	Classroom Lecture and Discussion	4, 5
11-12	**Distribution-Free Tests:** Runs test, Sign test, Kolmogorov-Smirnov test, Anderson-Darling test	Classroom Lecture and Discussion	4, 5
13-14	**Association Tests:** Spearman's rank correlation, Kendall's tau, Goodman and Kruskal's gamma, Multiple comparisons in nonparametric tests	Classroom Lecture and Discussion	4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. David, H. A. and Nagaraja H. N. (2003). Order Statistics, 3rd Edition, John Wiley, New York.
ii. Chakraborti, S. and Gibbons, J. D (1992). Nonparametric Statistical Inference, 5th Edition, Marcel Dekker, Inc., USA.

Supplementary Readings:

i. Arnold, B. C., Balakrishnan, N., and Nagaraja, H. N. (2008). A first course in order statistics. Society for Industrial and Applied Mathematics.
ii. Lehmann, E. L. and D'Abrera H. J. M. (2008). Nonparametric Statistical Methods Based on Ranks, Springer, New York.
iii. Balakrishnan, N. and Cohen, A. C. (1990). Order Statistics and Inference Estimation Method, Academy Press, New York.
iv. Hollander, M., Wolfe, D. A., & Chicken, E. (2013). Nonparametric Statistical Methods, 3rd Edition, Wiley.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4106	LAB - Bayesian Inference and Decision Making	LAB	1.0	

1. Rationale of the Course:

The course aims to equip students with a comprehensive understanding of Bayesian statistical methods and their application in decision-making, fostering the ability to utilize probabilistic reasoning for making informed choices and predictions in various analytical and research contexts.

2. Course Objectives:

The major objectives of this course include:

- To provide students with a strong theoretical foundation and practical skills in Bayesian inference, enabling them to apply Bayesian principles and facilitate informed decision-making in diverse practical and research-based settings.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to develop the proficiency to implement Bayesian statistical techniques, interpret Bayesian models, and data-driven decisions in various analytical, research, and problem-solving contexts.	1	1	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-4101: Bayesian Inference".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0610-4107	LAB - Application of Machine Learning Techniques	LAB	1.0	100

1. Rationale of the Course:

This course is designed to provide students with hands-on experience in implementing and applying a variety of machine learning algorithms.

2. Course Objectives:

The major objectives of this course include:

- To equip students with the theoretical foundations and practical skills necessary to apply a diverse range of machine learning algorithms.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to gain proficiency in implementing and evaluating various machine learning models.	1	2	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0610-4102: Machine Learning".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4108	LAB - Design of Experiments and Applications	LAB	1.0	100

1. Rationale of the Course:

The course is aimed at providing students with practical exposure to the principles and methodologies of experimental design, fostering a comprehensive understanding of their applications in various research and industrial contexts.

2. Course Objectives:

The major objectives of this course include:

- To equip students with the knowledge and skills required to design and conduct experiments effectively.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to develop the proficiency to design and implement efficient experimental plans, analyze experimental data using statistical techniques.	1	2	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-4103: Design and Analysis of Experiment".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4109	LAB - Applications of Non-Parametric Approaches	LAB	1.0	100

1. Rationale of the Course:

The course is designed to familiarize students with the practical application of non-parametric approaches.

2. Course Objectives:

The major objectives of this course include:

- equipping students with the necessary knowledge and skills to understand, apply, and evaluate various non-parametric techniques.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to develop the proficiency to apply a range of non-parametric methods, interpret their results, and assess their suitability in various data analysis tasks.	1	2	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-4105: Order Statistics and Non-Parametric Approaches".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Year 4, Semester 2:

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4201	Multivariate Analysis	Elective	3.0	100

1. Rationale of the Course:

Multivariate analysis skills have been recognized as part of the key requisites for statistical analysts. The complexity of most phenomena in the real world requires an investigator to collect and analyze observations on many different variables instead of a single variable. The purpose of the course is to develop skills needed to analyze and interpret multivariate data, enabling better decision-making and preparing them for data-driven careers.

2. Course Objectives:

This course is designed to introduce various topics in multivariate analysis and to provide experience with well-balancing three equally important elements: the mathematical theory; applications and interpretation to real data. The specific objectives include:

- To develop a thorough understanding of the theory and methods of multivariate data analysis.
- To interpret the results and test the assumptions of multivariate data analysis.
- To understand academic research employing multivariate techniques.
- To tackle multivariate analysis of variance (MANOVA), data reduction and dimensionality reduction, classification, predictor, and classifier instability problems in real data sets.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will be able to understand both the underlying mathematics and problems of applications in multivariate analysis.	3	2	2	1	1
2. Students can summarize, interpret, and carry out exploratory data analysis of multivariate data.	3	3	2	3	2
3. Students can learn the fundamental grounding in the use of data reduction and dimensionality reduction techniques.	2	3	3	2	2
4. Students can make appropriate classification and clustering in modeling the multivariate data.	1	2	2	3	3
5. Students will be able to utilize basic techniques of reproducible research in multivariate data analysis.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-2	**Introduction:** Meaning and Application of Multivariate Analysis, Meaning and Interpretation of Euclidian and Statistical Distances, Spectral Decomposition, Cholesky Decomposition of Positive Definite Matrix, Determining Square Root of Matrices, Partition of Covariance Matrices, Generalized Variance.	Classroom Lecture and Discussion	1, 2
3-4	**Multivariate Normal Distribution:** Definition and Properties of Multivariate Normal distribution, Determining Probability Density Contour, Maximum Likelihood Estimator of Mean Vector and Variance Covariance Matrix, Q-Q Plot, Chi-square Plot, Steps in Detecting Outliers and Cleaning Data, Transformation to Near Normality by Square Root, Logit, Fisher's and Box-Cox Transformation.	Classroom Lecture and Discussion	1, 2
5	**Multivariate Sampling Distributions:** Distribution of $\bar{\mathbf{X}}$ and S , Large-sample Distribution of $\bar{\mathbf{X}}$ and S with their Properties, Study of the Wishart Distribution and its Properties, Bartlett's Decomposition and the Generalized Variance, the Distribution of Latent Roots of a Dispersion Matrix.	Classroom Lecture and Discussion	1, 2
6-7	**Inferences about a Mean Vector: H**otelling's T^2 and Likelihood Ratio Tests, Confidence Regions and Simultaneous Comparisons of Component Means, Bonferroni Method of Multiple Comparisons, Inferences about Mean Vectors with Missing Data. **Multivariate Quality Control Charts:** Charts for Individual Multivariate Observation, Ellipse Format Chart, T^2 Chart, Control Region for Future Individual Observation, Control Ellipse and T^2 Chart for Future Observation,.	Classroom Lecture and Discussion	1, 2,5
8-9	**Inferences about Several Multivariate Means:** Comparing Mean Vectors from Two Populations, Paired Comparison and Repeated Measures Designs for Comparing Treatments **Multivariate Analysis of Variance(MANOVA):** One-Way MANOVA, Simultaneous Confidence Intervals for Treatment Effects, Two-Way MANOVA, and Profile Analysis.	Classroom Lecture and Discussion	2, 4, 5
10-11	**Principle Component Analysis (PCA):** Introduction to PCA, ML Estimator of the Principal Components and their Variances, Sampling Properties of the Sample	Classroom Lecture and Discussion	3, 4

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
	Principal Components, and Statistical Inference. Image Analysis using PCA.		
12	**Factor Analysis:** Definition and Purpose of Factor Analysis, the Mathematical Model for Factor Structure, ML Estimators for Random Orthogonal Factors, Estimation for Fixed Factors, Testing the Goodness of Fit of the Factor Model. Factor Interpretation and Transformation.	Classroom Lecture and Discussion	3
13	**Discriminant Analysis:** Meaning and Goals of Discriminations and Classification, Fisher's Linear Discriminant Function, Classification into One of Two and Into One of More than Two Multivariate Populations, Quadratic Discriminators, Test of a Discriminant Function.	Classroom Lecture and Discussion	4, 5
14	**Canonical Correlation and Canonical Variables:** concepts of Canonical Variables and Canonical Correlation, Estimation of Canonical Correlation and Varieties, Large Sample Statistical Inference of Canonical Correlation.	Classroom Lecture and Discussion	3, 4, 5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1 to CLO-5	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Johnson, R. A. and Wichern, D. W. (2007). Applied Multivariate Statistical Analysis, 6th Edition, Pearson Education, Asia.

Supplementary Readings:

i. Anderson, T. W. (2003). Introduction to Multivariate Analysis, 3rd Edition, John Wiley, New York.
ii. Izenman, A. J. (2008). Modern Multivariate Statistical Techniques, Regression, Classification and Manifold Learning, Springer-Verlag, Newwork.
iii. Everitt, B., & Hothorn, T. (2011). An introduction to applied multivariate analysis with R. Springer Science & Business Media.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4202	Categorical Data Analysis	Elective	3.0	100

1. Rationale of the Course:

This course is designed to provide a comprehensive understanding of statistical methods for analyzing categorical data. This course is crucial for students and professionals in fields such as biostatistics, social sciences, and market research, where the analysis of categorical data is a common requirement. The course aims to equip learners with the skills to perform accurate statistical inference, model building, and data interpretation for categorical data.

2. Course Objectives:

This course will introduce and demonstrate the statistical procedures for analyzing the categorical variables. The specific objectives include:

- To gain an understanding of distributions, statistical inference, and Bayesian inference for categorical data.
- To learn and apply different tests like the LM test, Wald test, likelihood ratio test, and Fisher's Exact Test for categorical data analysis.
- To acquire skills in analyzing and interpreting two-way contingency tables, including testing independence and measuring association.
- To understand generalized linear models for binary data and counts and develop skills in model fitting and diagnostics.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will develop a deep understanding of distributions for categorical data and perform statistical and Bayesian inference for binomial and multinomial parameters.	3	2	2	1	3
2. Students will become competent in applying various tests for categorical data analysis, understanding their implications and applications.	3	3	2	3	3
3. Students will acquire analytical skills for working with contingency tables, including measuring association and testing independence.	2	3	3	2	2
4. Students will gain proficiency in using generalized linear models for categorical data, including model checking and fitting.	1	2	2	3	3
5. Students will be able to utilize master basic techniques of reproducible research in categorical data analysis.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-2	**Introduction-Distributions and Inference for Categorical Data:** Categorical Response Data, Distributions for Categorical Data, Statistical Inference for Categorical Data, Statistical Inference for Binomial and Multinomial Parameters, Bayesian Inference for Binomial and Multinomial Parameters.	Classroom Lecture and Discussion	1
3	**Different test for the Categorical Data Analysis:** LM test, Wald test, likelihood ratio test for the contingency table, Fisher's Exact Test.	Classroom Lecture and Discussion	1, 2
4-5	**Contingency Tables and Inference for Two-Way Contingency Tables:** Probability Structure for Contingency Tables, Comparing Two Proportions, Conditional Association in Stratified Tables, Measuring Association in Tables. Confidence Interval for Association Parameters, Testing Independence in Two-Way Contingency Tables, Following up Chi-Square Tests, Two-Way Tables with Ordered Classifications, Small-Sample Tests of Independence	Classroom Lecture and Discussion	3
6-7	**Generalized Linear Model:** Generalized Linear Model, Generalized Linear Models for Binary Data, Generalized Linear Models for Counts, Moments and Likelihood for Generalized Linear Models, Inference and Model Checking for Generalized Linear Models, Fitting Generalized Linear Models, Quasi-Likelihood and Generalized Linear Models. Poisson Regression, Diagnosis test of the Poisson Regression Model	Classroom Lecture and Discussion	3
8	**Logistic Regression Model:** Interpreting Parameters in Logistic Regression, Inference for Logistic Regression, Logistic Models with Categorical Predictors, Multiple Logistic Regression, Fitting Logistic Regression Models, Strategies in Model Selection, Logistic Regression Diagnostics, Summarizing the Predictive Power of a Model, Mental-Haenszel and Related Methods	Classroom Lecture and Discussion	3

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
	for Multiple 2×2 Tables, Detecting and Dealing with Infinite Estimates, Sample Size and Power Consideration.		
9-10	**Models for Multinomial Responses**: Nominal Responses: Baseline-Category Logit Models, Ordinal Responses: Cumulative Logit Models, Ordinal Responses: Cumulative Link Models, Alternative Models for Ordinal Responses, Testing Conditional Independence In $I\times J\times K$ Tables, Discrete-Choice Multinomial Logit Models, Bayesian Modeling of Multinomial Responses.	Classroom Lecture and Discussion	3
11-12	**Model for Matched Pairs:** Comparing Dependent Proportions, Conditional Logistic Regression for Binary Matched Pairs, Marginal Models for Square Contingency Tables, Symmetry, Quasi-Symmetry, and Quasi-Independence, Measuring Agreement between Observers, Bradley-Terry Model for Paired Preferences, Marginal Models and Quasi-Symmetry Models for Matched Sets.	Classroom Lecture and Discussion	3
13-14	**Clustered Categorical Data- Marginal and Transitional Models:** Marginal Modeling: Maximum Likelihood Approach, Generalized Estimating Equations Approach, Quasi-Likelihood and its GEE Multivariate Extension, Transitional Models: Markov Chain and Time Series Models.	Classroom Lecture and Discussion	4, 5

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Agresti, A. (2012). Categorical Data Analysis, 3rd Edition, John Wiley and Sons, New York.
ii. Agresti, A. (2018). An introduction to categorical data analysis. 3rd Edition, Wiley.

Supplementary Readings:

i. Bilder, C. R., & Loughin, T. M. (2014). Analysis of categorical data with R. CRC Press.
ii. Powers, D. A. and Xie, Yu. (2008). *Statistical Methods for Categorical Data Analysis,* 2nd Edition, Emerald Group Publishing Ltd., London.
iii. Hosmer Jr, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). Applied Logistic Regression. John Wiley & Sons.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4203	Time Series Analysis and Forecasting	Core	3.0	100

1. Rationale of the Course:

This course will illustrate and equip students with various classical time series models, deriving their properties, inference methods, decomposition with seasonal adjustments, and forecasting techniques for analyzing real lifetime series data.

2. Course Objectives:

The specific objectives of this course:

- To understand the main concepts of time Series theory and methods of analysis.
- To learn standard time series analysis topics, e.g., modeling time series using regression analysis, univariate ARMA/ARIMA modeling, (G)ARCH modeling, Vector Autoregressive (VAR) model along with forecasting, model identification and diagnostics.
- To understand time-domain and frequency-domain methods in time series analysis.
- To implement modeling and forecasting time series data using R statistical software.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to summarize and carry out exploratory analysis of time series data. demonstrate a solid understanding of fundamental probability concepts.	3	2	2	1	2
2. Students should be able to learn the fundamental grounding in the use of widely used tools in time series modeling.	3	3	2	3	2
3. Students should be able to make forecast with high accuracy.	2	3	3	2	2
4. Students should be able to Implementation of time series models in real life problems.	1	2	3	3	2

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	**Introduction:** Meaning of Time Series, Objectives of Time Series Analysis, Simple Time Series Models, Stationary Models, Autocorrelation Function, Time Series Components	Classroom Lecture and Discussion	1
2-3	**Time Series Decomposition:** Estimation and Elimination of Trend and Seasonal Components, Moving Averages, Classical Decomposition, X11 Decomposition, SEATS Decomposition, STL Decomposition, Testing Estimated Noise Sequence.	Classroom Lecture and Discussion	1, 2
4-5	**Stationary Processes:** Basic Properties, Linear Processes, ARMA Processes, Properties of Sample Mean and	Classroom Lecture and Discussion	3

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
	Autocorrelation Function, Forecasting Stationary Time Series, World Decomposition.		
6-8	**ARMA Models:** ARMA (P, Q) Process, ACF and PACF of ARMA (P, Q) Process, Forecasting ARMA Process. **Spectral Analysis:** Spectral Densities, Periodogram, Time-Invariant Linear Filters, Spectral Density of ARMA Process	Classroom Lecture and Discussion	3, 4
9-11	**Modeling and Forecasting with ARMA Process:** Preliminary Estimation, Maximum Likelihood Estimation, Diagnostic Checking, Forecasting, Order Selection. **Non-stationary and Seasonal Time Series Models:** ARIMA Models for Nonstationary Time Series, Identification Techniques, Unit Roots in Time Series Models, Forecasting ARIMA Models, Seasonal ARIMA Models, Regression with ARMA Errors.	Classroom Lecture and Discussion	4
12-14	**Forecasting Technique:** Naïve procedures, Simple Exponential Smoothing, Holt-Winters method, Holt-Winters Seasonal method, Box-Jenkins Forecasting, Choosing Forecasting method, Forecast accuracy. **State-Space Models:** State-Space Representation, Basic Structural Model, State-Space Representation of ARIMA Models, Kalman Recursions.	Classroom Lecture and Discussion	4

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1 to CLO-5	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Brockwell, P. J. and Davis, R. A. (2016). Introduction to Time Series and Forecasting, 6th Edition, Springer, New York.
ii. Box, G. E. P. B., Jenkins, G.M., Reinsel, G,C. and Ljung, G, M. (2015). Time Series Analysis: Forecasting and Control. 5th Edition, Wiley.

Supplementary Readings:

i. Montgomery, D. C., Jennings, C. L., and Kulahci, M. (2015). Introduction to time series analysis and forecasting. John Wiley & Sons.
ii. Chatfield, C., & Xing, H. (2019). The analysis of time series: an introduction with R. Chapman and Hall/CRC.
iii. Woodward, W. A., Gray, H. L., & Elliott, A. C. (2021). Applied time series analysis with R. 2nd Edition. CRC Press.
iv. Shumway, R. H., Stoffer, D. S., and Stoffer, D. S. (2000). Time series analysis and its applications. New York: Springer.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0988-4204	Health Informatics	GED	3.0	100

1. Rationale of the Course:

"Health Informatics" is a multi-disciplinary field at the intersection of information science, computer science, and health care. This course will introduce fundamental characteristics of healthcare data, the common algorithms for health applications, and IT components in representative clinical processes. It also introduces the concepts of population health and precision medicine and the information systems that support them. This course will allow the students to be exposed with the building blocks of Health Informatics algorithms, medical decision-making, clinical process modeling, Knowledge management systems, and health IT standards.

2. Course Objectives:

This course is primarily designed to provide students with a fundamental understanding of health informatics and its applications. The specific objectives include:

- To understand the fundamentals of Health Informatics, Health Data Management and Analytics.
- To familiar with common algorithms for health applications and IT components.
- To understand population health and precision medicine, Healthcare Information Security and Privacy.
- To apply Health Informatics in Healthcare Decision-Making.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with Program Learning Outcomes (PLOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students will gain knowledge on Health Informatics, Data, Information.	3	2	2	1	1
2. Students will learn legal and ethical principles in health informatics	3	3	2	3	2
3. Students will understand Medical Algorithms and Medical Decision Making, Population Health and Precision Medicine.	2	3	3	2	2
4. Students will learn about Health Informatics standard, Management system and Organizing Health IT services.	1	2	3	3	3
5. Students will demonstrate skills and abilities for planning and introducing informatics tool within healthcare for improved knowledge, reliable and timely information, and decision support.	1	2	2	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1	Introduction of Health Informatics and its significance, Key Concepts in Health Informatics, Historical Overview and Future Challenges.	Classroom Lecture and Discussion	1
2	Ethics, Privacy, Sharing and Security	Classroom Lecture and Discussion	1,2
3-4	Healthcare Data, Information, Knowledge, Types of Healthcare Data and Information, Electronic Health Records, Purpose of Maintaining Patient Records, Common Issues and Challenges for Measuring and Ensuring Healthcare Data Quality, Quality management, Mobile Technology and mHealth	Classroom Lecture and Discussion	1,2
5	Information Retrieval, Evidence-Based Medicine and Clinical Practice Guidelines, Health Informatics Standard.	Classroom Lecture and Discussion	4
6-7	Medical and Computer Science Algorithms in Biomedicine, Concepts of Precision Medicine	Classroom Lecture and Discussion	3
8-9	Knowledge Management and Decision-Making Support in Biomedicine, Ways to Organize IT Services	Classroom Lecture and Discussion	4
10-11	Find and Apply Informatics in Genomics and Other Aspects of Molecular Biology, Medical Imaging Informatics.	Classroom Lecture and Discussion	5
12-14	Data Science Analytics in Health Informatics, Clinical Research Informatics, Telemedicine, Patient Safety and Health Information Technology.	Classroom Lecture and Discussion	5

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Classroom Lecture, Interactive Group Discussion, Multimedia Presentation	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.
CLO-2		
CLO-3		
CLO-4		
CLO-5		

6. Assessment and Evaluation

As per the process outlined in Part D.

7. Learning Materials

Recommended Readings:

i. Nelson, R., Staggers, N. (2015). Health Informatics: An interprofessional approach. 2nd Edition, Elsevier Health Sciences.
ii. William, R. H., Robert, E. H. (2022). Health Informatics: Practical Guide, 8th Edition.
iii. Wager, K. A., Lee, F. W., & Glaser, J. P. (2022). Health care information systems: A practical approach for health care management, 5th Edition. Jossey-Bass.

Supplementary Readings:

i. Robert E. H. (2014). Health Informatics. Practical Guide for Healthcare and Information Technology Professionals. 6th Edition.
ii. Pamela K. O. (2016). Health Information Management: Concepts, Principles, and Practice 5th Edition.
iii. Ziegler, A., and König, I., R., (2010). A Statistical Approach to Genetic Epidemiology-Concepts and Applications: Concepts and Applications, 2nd Edition, Wiley-Blackwell.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4205	LAB - Application of Multivariate Models	LAB	1.0	100

1. Rationale of the Course:

This course is designed to solve some practical problems by using statistical tools and software that are learned in the theoretical courses on Multivariate Models for Data Analysis.

2. Course Objectives:

The major objectives of this course include:

- To analysis data using statistical tools that are learned in the course Multivariate Data Analysis.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to gain practical knowledge about the complexity of data and analyze these data by using advanced statistical tools.	1	1	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-4201: Multivariate Analysis".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4206	LAB - Application of Categorical Data Analysis Models	LAB	1.0	100

1. Rationale of the Course:

This course is designed to solve some practical problems by using statistical tools and software that are learned in the theoretical courses on Categorical Data Analysis.

2. Course Objectives:

The major objectives of this course include:

- To analysis data using statistical tools that are learned in the course Categorical Data Analysis

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to gain practical knowledge about the complexity of data and analyze these data by using advanced statistical tools.	1	1	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-4202: Categorical Data Analysis".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4207	LAB - Time Series Analysis and Applications	LAB	1.0	100

1. Rationale of the Course:

This course is designed to solve some practical problems by using statistical tools and software that are learned in the theoretical courses on Time Series Analysis and Forecasting.

2. Course Objectives:

The major objectives of this course include:

- To analysis data using statistical tools that are learned in the course Time Series Analysis and Forecasting.

3. Course Learning Outcomes (CLOs) and Mapping of CLOs with PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
1. Students should be able to apply various time series analysis techniques to understand, model, and forecast complex temporal data, enabling them to make informed predictions, detect patterns, and derive meaningful insights for decision-making.	1	1	3	3	3

4. Course plan specifying content, CLOs, co-curricular activities (if any), teaching-learning, and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Corresponding CLOs
1-14	As per the theoretical course "0542-4203: Time Series Analysis and Forecasting".	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	1

5. Mapping CLOs with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO-1	Lab Exercises, Computer intensive learning, Interactive Workshops, Group work, Hands-on Coding Sessions, Case Studies, Project-Based Learning.	Quizzes, Oral questioning, Assignments, Class tests and performance, Presentations, and Semester end examination.

6. Assessment and Evaluation

As per the process outlined in Part D.

Course Code:	Course Title:	Course Type:	Credit Value:	Total Marks:
0542-4208	Project Work	Capstone	3.0	100

1. Rationale of the Course:

The capstone course is intended to provide students with a comprehensive and practical experience that integrates the knowledge and skills they have acquired throughout their coursework. It serves as a bridge between academia and the professional world, preparing students for successful careers in the rapidly evolving field of statistics and data science.

2. Modalities:

The students will complete the project work at the final semester of year four under the supervision of a supervisor assigned by the Department. However, the project work and the supervisor will be assigned at the beginning of the 4^{th} year (i.e., semester 1 of year 4).

3. Assessment:

The capstone course will be assessed as per the following criteria:

- Evaluation of Thesis – 70%
- Oral presentation – 30%

Part D
Grading, Evaluation & Other Operational Requirements

1. Related Operational Requirements

a. Total weeks in a semester – 26 weeks.

b. Total class-weeks in a semester – 14 weeks.

c. Classes per week:
- For 3-credit Theoretical course – 2 classes.
- For 1-credit LAB/practical course – 1 class.

d. Duration of each class:
- For 3-credit Theoretical course – 1 ½ hours.
- For 1-credit LAB/practical course – 2 hours.

e. Total classes:
- For 3-credit Theoretical course – 28 classes.
- For 1-credit LAB/practical course – 14 classes.

f. Total marks assigned to a course – 100 marks.

The Department of Statistics and Data Science runs two semesters a year and gets 14 weeks to complete the required classes. A Semester End Examination (SEE) shall be held at the end of each Semester. Students shall get two weeks of preparation leave before SEE. The key operational requirements to run the program can be summarized as follow:

Table 1: Basic Operational Requirements

Sl. #	Operational requirements	4 years BSc (Honors)
Requirements to complete the program		
1	Semesters per year	2
2	Total semesters required	8
Requirements to run a semester-based program		
3	Total class weeks in a semester	14
5	Preparation leaves before SEE (in weeks)	3
6	Duration of SEE (in weeks)	5
7	Semester break (in weeks)	4
Total weeks in a semester		***26***

2. Grading Criteria

The Grading Scale, Grades, Grade Point Average (GPA), Cumulative Grade Point Average (CGPA), Course Withdrawal, Incomplete (I) courses, Retake, Grade Improvement, Dropout, etc. are set as per the JU Examination Ordinance.

Table 2: Grading system: Existing JU and UGC grading system

Numerical Grade	Grade	Grade Point
80% and above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	D	2.00
Less than 40%	F	0.00
Incomplete	I	0.00

3. Evaluation System for Theory Courses

The Department of Statistics and Data Science adopts a framework for the assessment of its students as advised in the UGC's OBE guideline. Marks of each course is 100 marks. The assessment pattern of the Department of Statistics and Data Science comprises - Continuous Internal Evaluation (CIE), and Semester End Examination (SEE).

- Continuous Internal Evaluation (CIE) carries – 40 Marks.
- Semester End Examination (SEE) carries – 60 Marks.

Individual students are evaluated based on the following criteria with the following marks distribution:

Table 3: Marks distribution of theory courses with different assessment techniques

Sl. #	Assessment Techniques	Marks (%)
Continuous Internal Evaluation (CIE)		
1	Class Tests	20%
2	Assignment	5%
3	External Participation in Curricular/Co-curricular Activities /Presentation of assignment, etc.	5%
4	(i) Quizzes	5%
	(ii) Attendance	5%
Semester End Examination (SEE)		
5	Semester End Examination	60%
Total		***100%***

3.1 Assessment Pattern

The assessment of students under each course follows the **Outcome Based Evaluation (OBE)** system and in accordance with the **Bloom's Taxonomy** as adopted by the UGC of Bangladesh. Bloom's taxonomy is a hierarchical classification system used to define and distinguish different levels for the students in terms of Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating, as follows:

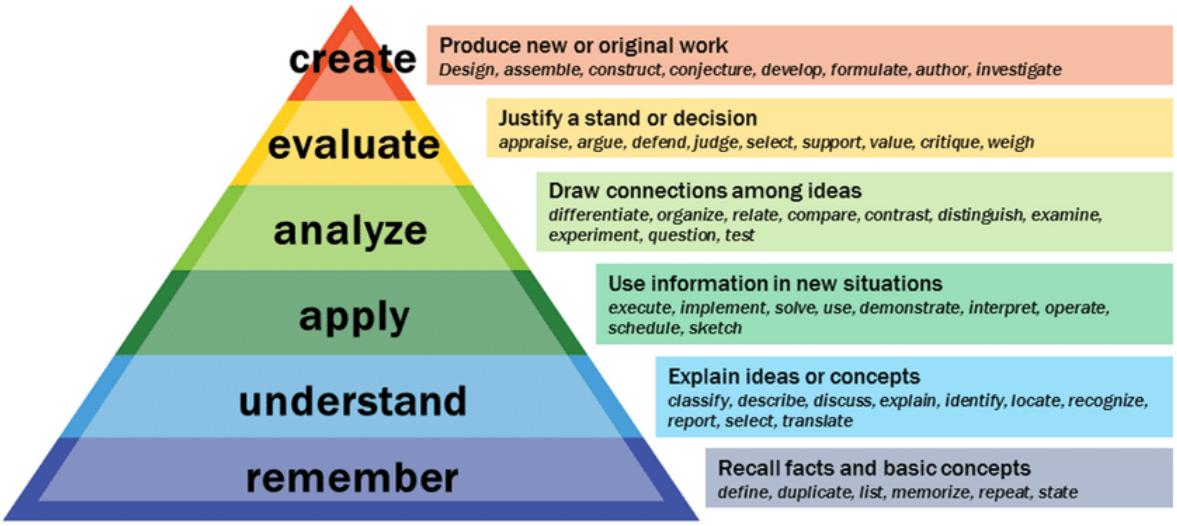

Figure 1: Using Bloom's Taxonomy

3.2 Continuous Internal Evaluation (CIE) for Theory Courses – 40 Marks

The students are continuously evaluated throughout the semester by adopting several assessment methods, e.g., class test, assignment, quizzes /class participation/ attendance and external participation in curricular/co-curricular activities. Each assessment method of CIE follows the following marks distribution in accordance with the Bloom's Taxonomy:

Table 4: Marks distribution for different CIE assessment tools as per Bloom's Taxonomy

Bloom's Category Marks (40)	**Tests (20)**	**Assignments (5)**	**Participation in curricular/ co-curricular activities/presentation (5)**	**Quizzes/ attendance (10)**
Remember				5
Understand		3		5
Apply	5		5	
Analyze	10			
Evaluate	5			
Create		2		

The continuous internal evaluation under each theory course include: **minimum** 2 Class tests/Tutorials, 1 Assignment, 2 Quiz and 1 Presentation on external participation in curricular/co-curricular activities/assignments as per the following schedule:

Table 5: Suggested schedule of different assessment tools of CIE

SL#	Evaluation methods	Total unit*	Total Marks	Schedule *
1	Class test/ Tutorial	2	20	• 1st test – after 14th class • 2nd test – after 28th class
2	Assignment	1	5	• Initiate preferably after 16th class
3	Presentation	1	5	• After 25th class (based on assignment, case study, mini survey, mini project, field visit, etc.)
4	Quiz	2	5	• 1st Quiz – before 14th class • 2nd Quiz – before 28th class
	Attendance	-	5	• Shall be calculated as per the 'Marks calculation for class attendance'
Total Marks		**40**		

* If deemed necessary, course teachers can slightly change the schedule of tests/ assignments in consultation with the Chairman of the respective Exam Committee.

Marks calculation for class attendance

The marks obtained by a student in class attendance shall be calculated in proportion to the total number of classes attended by that student, i.e.,

$$\text{Marks in class attendance} = \frac{Number\ of\ classes\ attended\ by\ a\ student}{Total\ number\ of\ classes\ taken\ in\ a\ course} \times Total\ marks\ in\ class\ attendence\ (i.e., 10).$$

Marks in class attendance shall be presented in two decimal places. A student with a class attendance of less than 40% in a particular course will get zero (0) for that course.

Example: Suppose 28 classes were conducted in a course and a student attended 24 classes. Then his/her marks in the class attendance (out of 10) is:

$$\text{Marks in class attendance} = \frac{24}{28} \times 10 = 8.57$$

3.3 Semester End Examination (SEE) for Theory Courses – 60 Marks

Duration of SEE shall be 3 hours. Each assessment method of SEE adopts the following marks distribution in accordance with the Bloom's Taxonomy:

Table 6: Marks distribution of SEE of Theory courses as per Bloom's Taxonomy

Bloom's Category	**SEE (60)**
Remember	10
Understand	10
Apply	15
Analyze	10
Evaluate	10
Create	5
Total Marks	**60**

Questions Pattern for a Theory Course

As per OBE guideline, each course should be evaluated considering six learning levels and thus the question papers of **SEE** should be designed to evaluate student's ability in remembering, understanding, applying, analyzing, evaluating, and creating. Under this circumstance, a question paper for a theory course supposed to consider the following six parts:

- Part A: Questions related to **remembering**,
- Part B: Questions related to **understanding**,
- Part C: Questions related to **applying**,
- Part D: Questions related to **analyzing**,
- Part E: Questions related to **evaluating**, and
- Part F: Questions related to **creating**.

The questions pattern with marks distribution is outlined below:

Table 7: SEE questions pattern for theory courses

Section	**Bloom's Category**	**SEE (60)**	**General instructions**	**Marks**
Part A	Remember	10	Answer any 05 out of 06	5×2.0=10
Part B	Understand	10	Answer any 04 out of 05	4×2.5=10
Part C	Apply	15	Answer any 03 out of 04	3×5.0=15
Part D	Analyze	10	Answer any 02 out of 03	2×5.0=10
Part E	Evaluate	10	Answer any 02 out of 03	2×5.0=10
Part F	Create	5	Answer any 01 out of 02	1×5.0=05
Total Marks		**60**	**-**	**60**

Choosing Appropriate Action Verbs

It is important to use appropriate action verbs for setting questions in the class tests, tutorials, Quiz or even in the semester end examinations. The use of appropriate action verbs facilitates

alignment of program and course learning outcomes and course learning outcomes with assessments. Some examples of appropriate action verbs to be used to assess student's competency at different learning levels are summarized in the table below:

Table 8: Suggested action verbs for questions setting at different learning levels

Learning levels	**Description**	**Suggested action verbs** ***(Start questions with…)***
Level 1: Remembering	Retrieving, recognizing, and recalling relevant knowledge from long-term memory	Define, Count, Draw, Find, Identify, Label, List, Match, Name, Quote, Recall, Recite, Tell, Write
Level 2: Understanding	Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, and explaining	Describe, Discuss, Explain, Give examples of, Conclude, Demonstrate, Identify, Illustrate, Interpret, Predict, Review, Summarize
Level 3: Applying	Carrying out or using a procedure for executing, or implementing	Apply, Calculate, Predict, Solve, Determine, Compute, Execute, Implement, Prepare, Produce, Select, Show, Transfer, Use
Level 4: Analyzing	Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing	Analyze, Characterize, Classify, Compare, Contrast, Differentiate, Discriminate, Distinguish, Debate, Examine, Outline, Relate, Separate, Categorize, Simplify, Associate
Level 5: Evaluating	Making judgments based on criteria and standards through checking and critiquing	Appraise, Argue, Assess, Choose, Conclude, Criticize, Determine, Decide, Evaluate, Judge, Justify, Predict, Prioritize, Prove, Rank, Rate, Relate, Select, Support
Level 6: Creating	Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing	Construct, Create, Compose, Design, Derive, Develop, Formulate, Generate, Integrate, Invent, Make, Modify, Organize, Perform, Plan, Produce, Propose, Rewrite

4. Evaluation System for LAB Courses

Marks of each LAB course is 100 marks. Like Theory courses, the assessment pattern of a LAB course also comprises – Continuous Internal Evaluation (CIE), and Semester End Examination (SEE) with the following marks distribution:

- Continuous Internal Evaluation (CIE) carries – 60 Marks.
- Semester End Examination (SEE) carries – 40 Marks.

Individual students shall be evaluated in a LAB course based on the following criteria with the following marks distribution:

Table 9: Marks distribution of LAB courses with different assessment techniques

Sl.#	Assessment Techniques	Marks/ Percentage
Continuous Internal Evaluation (CIE) – 60% marks		
1	LAB tests	20%
2	LAB Report/Assignment / Presentation	10%
3	LAB Participation and Performance/Quiz	20%
4	LAB Attendance	10%
Semester End Examination (SEE) – 40% marks		
5	LAB Final Exam	30%
6	LAB Viva/ In LAB Evaluation	10%
Total		**100%**

4.1 Continuous Internal Evaluation (CIE) for LAB Courses – 60 Marks

The continuous internal evaluation under each LAB course shall include **minimum** 2 LAB tests, 1 Assignment with presentation, Lab performance as per the following schedule:

Table 10: Suggested schedule of different assessment tools of CIE

SL#	Evaluation methods	Total unit	Total Marks	Schedule *
1	LAB test	2	2×10=20	• 1st test – after 7th class • 2nd test – after 14th class
2	Assignment	1	5	• Initiate preferably after 8th class
	Presentation	1	5	• After 12th class (based on assignment, case study, mini survey, mini project, field visit, etc.)
3	LAB Performance	Quiz (2)	2×5=10	• 1st test – before 7th class • 2nd test – before 14th class
		Performance assessment (1)	10	• Performance should be assessed after each LAB class based on completion of the assigned problems/tasks
4	LAB Attendance	-	10	• Shall be calculated as per the 'Marks calculation for class attendance'
Total Marks		**60**		

* If deemed necessary, course teachers can slightly change the schedule of tests/ assignments in consultation with the Chairman of the respective Examination Committee.

4.2 Semester End Examination (SEE) for LAB Courses – 40 Marks

The SEE of a LAB course shall be conducted as per the following modalities:

- Course teacher will prepare question paper for SEE and responsible for evaluating SEE scripts.
- Course teacher and at least two additional faculty members, nominated by the respective exam committee, will be responsible for conducting LAB exam and in LAB evaluation/viva for each course.