Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
Autonomous
Course Structure for M.Sc. Statistics (2022 Pattern)
(w. e. from June, 2022)

Name of the Programme : M.Sc. Statistics

Program Code : PSST

Class : M.Sc. Part – I

Semester : I

Paper Code	Title of Paper	No. of Credits
PSST111	Mathematical Analysis	4
PSST112	Linear Algebra	4
PSST113	Probability Distributions	4
PSST114	Sampling Theory	4
PSST115	Statistics Practical – I	4
PSST116	Statistics Practical – II	4

Name of the Programme : M.Sc. Statistics

Program Code : PSST

Class : M.Sc. Part – I

Semester : II

Paper Code	Title of Paper	No. of Credits
PSST121	Probability Theory	4
PSST122	Parametric Inference	4
PSST123	Multivariate Analysis	4
PSST124	Regression Analysis	4
PSST125	Statistics Practical – III	4
PSST126	Statistics Practical – IV	4

SYLLABUS (CBCS) FOR M.Sc. Statistics
(w. e. from June, 2022)

Name of the Programme : M.Sc. Statistics
Program Code : PSST
Class : M.Sc. Part – I
Semester : I
Course Name : Mathematical Analysis
Course Code : PSST111
No. of lectures : 60
Credit : 4 credits

A) Course Objectives:

1. Rigorous understanding of mathematical concepts such as metric space, sequences, series, limits, and continuity.
2. Throughout the course, students will be exposed to various applications of mathematical analysis in statistics.
3. They will learn about approximation methods and techniques, such as Taylor series expansions, which are crucial for statistical estimation and inference.
4. Students will learn to apply these concepts to analyze statistical functions, models, and data.
5. Development of students' ability to construct and understand mathematical proofs.
6. Students will study different types of convergence.

B) Course Outcomes:

By the end of the course, students should be able to:

CO1. students will develop strong analytical and logical reasoning skills through the study of mathematical analysis.

CO2. comprehend and construct rigorous mathematical proofs, and use deductive reasoning to solve complex mathematical problems.

CO3. Understand the fundamental mathematical concepts which will useful in learning probability theory course.

CO4. acquire the knowledge to analyze mathematical problems in the context of statistics.

CO5. understand the different types of convergence, such as pointwise convergence, uniform convergence.

CO6. construct and understand mathematical proofs on various results.

CO7. Understand the concepts which required for further studies in Probability Theory and Asymptotic Inference.

TOPICS/CONTENTS:

Unit 1:

Set of real numbers, supremum and infimum of sets of real numbers, real field, Euclidean spaces, Finite, Countable and uncountable sets, metric spaces, interior points and limit points of a set, open set, closed set and Compact set. Bolzano-Weierstrass theorem and Heine-Borel theorem (statement only). Application of these theorems.

(15L)

Unit 2:

Sequence of real numbers, convergence and divergence of sequence, subsequences of a sequence, Cauchy sequences, completeness of R, limit inferior, limit superior of the sequences, some special sequences.

(15L)

Unit 3:

Series of real numbers, convergence of series, tests for convergence of series (ratio test, root test) (without proof), alternative series, conditional and absolute convergence, power series and radius of convergence, examples and problems on these concepts.

(15L)

Unit 4:

Limits of functions, continuous function, discontinuity, uniform continuity, continuity and compactness, monotone function and discontinuity. Introduction and examples of sequence of real valued function, pointwise convergence of sequence of functions, definition of uniform convergence of sequence of function. Riemann integral, refinement of partitions, condition of integrability, Riemann sums, fundamental theorem of calculus, definition and existence of Riemann-Stieltjes integral, a condition of integrability

(15L)

References:

1. Ajit Kumar (2019), A Basic Course in Real Analysis, A Chapman & Hall Book.

2. Apostol T.M. (1975). Mathematical Analysis: A modern approach to advanced calculus. Addison- Wesley
3. Bartle R. G. (1976). Elements of Real Analysis, John Wiley
4. Bartle R.G. & Sherbert D.R. (2000): Introduction to Real Analysis-John Wiley & Sons Inc.
5. Ghorpade, S. R. and Limaye, B. V. (2006). A Course in Calculus and Real Analysis, Springer
6. Goldberg R.R.(1964): Methods of Real Analysis-Blaisell Publishing company, New York, U.S.A.
7. Kumar A. and Kumaresan S. (2014), A basic course in real analysis, CRC Press.
8. Mapa S. K. (2018) Inroduction to Real Analysis, Sarat Book Distributors, Kolkata
9. Rudin, W. (1985). Principles of Mathematical Analysis, McGraw-Hill

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3								
CO2		3							
CO3									
CO4				2					
CO5					2				
CO6						3			
CO7									

Justification:

PO1 - Disciplinary Knowledge

CO1 (Weightage: 3): Developing strong analytical and logical reasoning skills through mathematical analysis strongly aligns with disciplinary knowledge in mathematics.

PO2 - Critical Thinking and Problem Solving

CO2 (Weightage: 3): Comprehending and constructing rigorous mathematical proofs and using deductive reasoning to solve complex mathematical problems directly relates to enhanced critical thinking and problem-solving skills.

PO3 - Social Competence

(No direct alignment observed): None of the COs strongly align with Social Competence.

PO4 - Research-related Skills and Scientific Temper

CO4 (Weightage: 2): Acquiring the knowledge to analyze mathematical problems in the context of statistics moderately relates to research-related skills, especially in statistical analysis.

PO5 - Trans-disciplinary Knowledge

CO5 (Weightage: 2): Understanding different types of convergence, such as pointwise and uniform convergence, moderately contributes to trans-disciplinary knowledge by integrating mathematical concepts across various domains.

PO6 - Personal and Professional Competence

CO6 (Weightage: 3): Constructing and understanding mathematical proofs on various results significantly contribute to personal and professional competence by showcasing advanced mathematical skills applicable in various contexts.

PO7 - Effective Citizenship and Ethics

(No direct alignment observed): None of the COs strongly align with Effective Citizenship and Ethics.

SYLLABUS (CBCS) FOR M.Sc. Statistics
(w. e. from June, 2022)

Name of the Programme	**:** M.Sc. Statistics
Program Code	**:** PSST
Class	**:** M.Sc. Part – I
Semester	**:** I
Course Name	**:** Linear Algebra
Course Code	**:** PSST112
No. of lectures	**:** 60
Credit	**:** 4 credits

A) Course Objectives:

1. Use the basic concepts of vector and matrix algebra
2. Understand real vector spaces and subspaces and apply their properties.
3. Solve systems of linear equations using various methods
4. Understand concepts required in advanced statistical and machine learning techniques.
5. Evaluate mathematical expressions to compute quantities that deal with linear systems and eigen value problems.
6. Construct a spectral decomposition of a matrix.
7. Characterize and classify quadratic forms using eigen values and eigenvectors

B) Course Outcomes:

By the end of the course, students should be able to:

CO1. understand the concepts of vectors, matrices, linear transformations, and systems of linear equations.

CO2. familiar with the properties and characteristics of vector spaces, concepts like subspaces, basis, linear independence and dimension.

CO3. learn about eigen values and eigenvectors and their applications in various fields.

CO4. explore inner product spaces, orthogonality and orthogonal projections.

CO5. apply the concept of decomposition of a matrix.

CO6. understand the concepts of quadratic forms and solve problems.

CO7. explore applications of linear algebra in multivariate analysis, linear models etc.

TOPICS/CONTENTS:

Unit 1:

Vector space, subspace, linear dependence and independence, basis and dimension of a vector space, orthogonal and orthonormal vectors, null space, Gram-Schmidt Orthogonalization process, orthonormal basis, orthogonal projection of vector, algebra of matrices, row and column spaces of a matrix, elementary operations. **(15 L)**

Unit 2:

Partitioned matrix, Elementary matrix, Determinant of a matrix, elementary properties, Determinant and inverse of partitioned matrix, Kronecker product. Rank of a matrix, rank and nullity, inverse of a matrix null space, idempotent matrix, Generalised inverse, Moore-Penrose generalized inverse, solution of a system of homogenous and non-homogeneous linear equation, theorem related to existence of solution and examples **(15 L)**

Unit 3:

Eigen values and eigen vectors, eigen spaces, Geometric and algebraic multiplicity of an eigen value, Properties of eigen values. Right and left characteristic vector, orthogonal property of characteristic vector Cayley-Hamilton theorem and minimal polynomial, application of Caley Hamilton theorem and its applications. Spectral decomposition of real symmetric matrix singular value decomposition, nth power of a matrix, Jordan decomposition. **(15 L)**

Unit 4:

Real Quadratic form (QF), Classification, Rank and signature, reduction of any QF to diagonal form. Definiteness of a matrix, equivalence of nonnegative definite matrix and variance covariance matrix, Simultaneous reduction of two QF, simultaneous reduction of two quadratic forms, maxima and minima of ratio of quadratic form. **(15 L)**

References:

1. Graybill, F.A(1961) An Introduction to Linear Statistical Models Vol 1,McGraw-Hill Book Company Inc.
2. Hadely G.(1962) Linear Algebra,Narosa Publishing House.
3. Harville D. (1997) Matrix Algebra From Statistics Perspective,Springer.
4. Kumaresan S. (2000), Linear Algebra: A geometric approach, Prenttice Hall.
5. R. B. Bapat Linear Algebra and Linear Models.
6. Rao A.R. and Bhimasankaram P.(2000),Linear Algebra,Second edition,Hindustan Book Agency.
7. Rao C.R. (2001) Linear Statistical Inference and Its Application,Second Edition,Wiley.
8. Schott J. (2016) Matrix Analysis for Statistics,Third edition Wiley.
9. Searl S.B.(2006) Matrix Algebra Useful for Statistics,Wiley.

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3								
CO2		3							
CO3				3					
CO4					3				
CO5						2			
CO6									
CO7									

Justification:

PO1 - Disciplinary Knowledge

CO1 (Weightage: 3): Understanding the concepts of vectors, matrices, linear transformations, and systems of linear equations directly aligns with disciplinary knowledge in linear algebra and its applications.

PO2 - Critical Thinking and Problem Solving

CO2 (Weightage: 3): Being familiar with the properties and characteristics of vector spaces, subspaces, basis, linear independence, and dimension demonstrates critical thinking and problem-solving abilities in abstract mathematical concepts.

PO3 - Social Competence

(No direct alignment observed): None of the COs strongly align with Social Competence.
PO4 - Research-related Skills and Scientific Temper
CO3 (Weightage: 3): Learning about eigenvalues, eigenvectors, and their applications in various fields strongly relates to research-related skills, especially in understanding mathematical concepts with broad applications.
PO5 - Trans-disciplinary Knowledge
CO4 (Weightage: 3): Exploring inner product spaces, orthogonality, and orthogonal projections significantly contributes to trans-disciplinary knowledge by integrating mathematical concepts across different fields.
PO6 - Personal and Professional Competence
CO5 (Weightage: 2): Applying the concept of decomposition of a matrix moderately relates to personal and professional competence, showcasing the ability to break down complex structures.
PO7 - Effective Citizenship and Ethics
(No direct alignment observed): None of the COs strongly align with Effective Citizenship and Ethics.

SYLLABUS (CBCS) FOR M.Sc. Statistics
(w. e. from June, 2022)

Name of the Programme	**:** M.Sc. Statistics
Program Code	**:** PSST
Class	**:** M.Sc. Part – I
Semester	**:** I
Course Name	**:** Probability Distributions
Course Code	**:** PSST113
No. of lectures	**:** 60
Credit	**:** 4 credits

A) Course Objectives:

1. Explore various types of probability distributions: The course typically covers different types of probability distributions, including discrete distributions, as well as continuous distributions.
2. Learn how to calculate and interpret probabilities: Students are taught techniques for calculating probabilities associated with different probability distributions. They learn how to use probability mass functions (PMFs) for discrete distributions and probability density functions (PDFs) for continuous distributions. They also learn how to interpret these probabilities in real-world contexts.
3. Study properties and characteristics of probability distributions: The course delves into important properties and characteristics of probability distributions, such as mean, variance, moment-generating functions, and cumulative distribution functions. Students learn how to calculate these measures and understand their significance.
4. Apply probability distributions to real-world scenarios: The course emphasizes the application of probability distributions to solve problems in various fields, including statistics, engineering, finance, and social sciences. Students learn how to model and analyze real-world situations using appropriate probability distributions.
5. Develop skills in data analysis and statistical inference: Probability distribution concepts are often essential in statistical inference and data analysis.
6. Gain proficiency in statistical software: Many probability distribution courses incorporate the use of statistical software packages to perform calculations and simulations. Students may learn how to use software like R, Python, or Excel to analyze

and visualize data based on probability distributions.

7. Enhance critical thinking and problem-solving skills: Through the study of probability distributions, students develop critical thinking and problem-solving skills. They learn how to apply mathematical concepts to real-world situations, analyze problems, and make informed decisions based on probability

B) Course Outcomes:

CO1. understand characteristics about discrete and continuous random variable and their probability distributions.

CO2. prepare students for modeling real data using distributions

CO3. develop understanding of distribution theory related for further advanced topics in statistical inference.

CO4. develop problem-solving techniques to solving real-world events.

CO5. apply selected probability distributions to solve problems.

CO6. Present the analysis of derived statistics to all audiences.

CO7. Develop problem-solving techniques needed to accurately calculate probabilities

TOPICS/CONTENTS:

Unit 1:

Random experiments and it's sample space, probability axioms, random variables, probability distribution of random variables, discrete and continuous random variable, functions of random variables and its distribution, mixture of probability distribution, m.g.f, p.g.f of distribution function. Moment inequalities: Markov, Chebychev, Holder, Minkowski and Jensen's inequalities with their applications. Basic inequality **(15 L)**

Unit 2:

Multiple random variables, joint, marginal and conditional distribution, variance covariance matrix, independence of random variables, marginal and conditional densities using joint densities, conditional expectations and variance, convolution of random variable, compound distribution, exponential family of distribution, location and scale families, non-regular family. **(15 L)**

Unit 3:

Bivariate normal, bivariate Poisson, bivariate exponential, (Olkins method 3 types), multinomial, Dirichlet, sampling distribution of statistics from univariate normal random samples. **(15 L)**

Unit 4:

Non-central χ^2, t, F distribution and their properties, distribution of linear and quadratic forms in iid standard normal variable (technique based on m.g.f.), Independence of two linear forms, Independence of two quadratic forms and independence of linear and quadratic forms, order statistics, joint distribution of order statistics, distribution of r^{th} order statistics, joint distribution of (r^{th} and s^{th} order statistics and their function), distribution of range. **(15 L)**

References:

1. Anirban DasGupta, Fundamentals of Probability: A First Course
2. Casella and Burger(2002) Statistical Inference (Duxbury advanced series II edition)
3. Feller, Fundamentals of Probability: A First Course
4. Hogg R. V. and Craig R. G. (1978): Introduction to Mathematical Statistics Ed.4.
5. Johnson N.L. & Kotz S.(1996) Distributions in statistics Vol.I .VolI and Vol III John Wiley and sons Inc.)
6. Johnson N.L., Kotz S., Balkrishnan, N. Multivariate Distributions (John Wiley and sons)
7. Rohatagi V.K. & Saleh A.K.(2001) Introduction to probability theory and mathematical statistics. (John Wiley and sons)
8. Rohatgi V. K. and Saleh A. K. Md. E. (2002): An Introduction to probability and statistics, John wiley & Sons (Asia)

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3								
CO2		3							
CO3				3					
CO4					2				
CO5						3			
CO6			2						
CO7								2	

PO1 - Disciplinary Knowledge

CO1 (Weightage: 3): Understanding characteristics about discrete and continuous random variables and their probability distributions directly contributes to disciplinary knowledge in probability and statistics.

PO2 - Critical Thinking and Problem Solving

CO2 (Weightage: 3): Preparing students for modeling real data using distributions requires critical thinking and problem-solving skills applied in statistical modeling.

PO3 - Social Competence

CO6 (Weightage: 2): Presenting the analysis of derived statistics to all audiences moderately contributes to social competence by enhancing communication skills to present complex information effectively.

PO4 - Research-related Skills and Scientific Temper

CO3 (Weightage: 3): Developing an understanding of distribution theory related to further advanced topics in statistical inference strongly relates to research-related skills and scientific temper in statistics and inference.

PO5 - Trans-disciplinary Knowledge

CO4 (Weightage: 2): Developing problem-solving techniques to solve real-world events moderately contributes to trans-disciplinary knowledge by applying probability distributions in practical situations across various fields.

PO6 - Personal and Professional Competence

CO5 (Weightage: 3): Applying selected probability distributions to solve problems significantly contributes to personal and professional competence by applying statistical knowledge in problem-solving scenarios.

PO7 - Effective Citizenship and Ethics

CO7 (Weightage: 2): Developing problem-solving techniques needed to accurately calculate probabilities moderately relates to effective citizenship and ethics by utilizing statistical principles responsibly.

SYLLABUS (CBCS) FOR M.Sc. Statistics
(w. e. from June, 2022)

Name of the Programme : M.Sc. Statistics
Program Code : PSST
Class : M.Sc. Part – I
Semester : I
Course Name : Sampling Theory
Course Code : PSST114
No. of lectures : 60
Credit : 4 credits

A) Course Objectives:

1. To introduce the statistical aspects associated with the design and analysis of sample surveys, and to develop your understanding of the principles and methods used to design survey sampling schemes.
2. Understand the steps in developing a sampling plan.
3. Distinguish between probability and non-probability sampling.
4. Develop critical thinking on sampling methods and results.
5. Understand potential sources of error and limitations of different sampling techniques.
6. To introduce the fundamental concepts and principles of research, including the scientific method, research questions and research designs.
7. To develop skills in designing research studies, including formulating research questions, selecting appropriate research designs.
8. To develop critical thinking to evaluate research studies, methodologies, and findings.

B) Course Outcomes:

By the end of the course, students should be able to:

CO1. define principal concepts about sampling.

CO2. lists the stages of sampling process.

CO3. understand the distinctive features of different sampling techniques and their related estimation problems.

CO4. learn the practical applications of the various sampling techniques in real life situations.

CO5. lists the stages of sampling process.

CO6. categorizes and defines the sampling methods.

CO7. apply the appropriate sampling method.

TOPICS/CONTENTS:

Unit 1:

Objectives of sample survey, planning for sample survey, concept of sampling distribution of statistic, Simple random sampling with replacement, Simple random sampling without replacement, systematic sampling and related results on estimation of population total, mean and proportion, circular systematic sampling, stratified sampling: formation of strata and number of strata, allocation problems and estimation problems, deep stratification and method of collapsed strata. **(15L)**

Unit 2:

Inclusion probabilities, Probability Proportional to Size With Replacement (PPSWR) methods, cumulative total method and Lahiri's method for estimation problem, estimation of finite population mean and total, PPSWOR methods and related estimation of a finite population mean (Horvitz-Thompson and Des Raj estimators for a general sample size and Murthy's estimator for a sample of size 2), Midzuno sampling, Rao-Hartley-Cochran sampling strategy. **(15L)**

Unit 3:

Use of supplementary information for estimation: ratio and regression estimators and their properties. Unbiased and almost unbiased ratio type estimators of population mean, post stratification, Cluster sampling cluster sampling with clusters of equal sizes and unequal sizes, Two – stage sampling with equal number of second stage units, multistage-sampling, stratification estimator, multiphase sampling. **(20L)**

Unit 4:

Sampling and non-sampling errors, Response and non response errors, Hansen–Hurwitz and Deming's model for the effect of call-backs, Randomized response technique (RRT), Warner's model, MLE in Warner's model, related and unrelated questionnaire methods. **(10L)**

References:

1. Des Raj & Chandhok P.(1998), Sample survey theory. (Narosa)

2. Murthy M.N.(1977) Sampling theory and methods. (Statistical Publishing Society)
3. Parimal Mukhopadhyay, Theory and methods of survey sampling, Prentice Hall of India private limited, 2nd Edition, 2008.
4. Sukhatme P.V. Sukhatme B.V. and C. Ashok Sampling theory of survey and applications. (Indian society for Agricultural statistics)
5. W.G.Cochran, (1977) Sampling techniques.(John Wiley and sons)

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3								
CO2									
CO3					3				
CO4				2					
CO5									
CO6		3							
CO7						2			

Justification:

PO1 - Disciplinary Knowledge
CO1 (Weightage: 3): Defining principal concepts about sampling aligns directly with disciplinary knowledge in the field of sampling methodologies and statistics.
PO2 - Critical Thinking and Problem Solving
CO6 (Weightage: 3): Categorizing and defining sampling methods requires critical thinking and problem-solving skills in understanding and organizing various sampling techniques.
PO3 - Social Competence
(No direct alignment observed): None of the COs strongly align with Social Competence.
PO4 - Research-related Skills and Scientific Temper
CO4 (Weightage: 2): Learning the practical applications of various sampling techniques in real-life situations moderately relates to research-related skills, especially in understanding the practical implications of sampling methodologies.
PO5 - Trans-disciplinary Knowledge
CO3 (Weightage: 3): Understanding the distinctive features of different sampling techniques and their related estimation problems significantly contributes to trans-disciplinary knowledge by integrating statistical sampling concepts across various domains.
PO6 - Personal and Professional Competence

CO7 (Weightage: 2): Applying the appropriate sampling method moderately contributes to personal and professional competence by demonstrating the ability to choose and apply suitable methodologies in specific contexts.

PO7 - Effective Citizenship and Ethics

(No direct alignment observed): None of the COs strongly align with Effective Citizenship and Ethics.

SYLLABUS (CBCS) FOR M.Sc. Statistics
(w. e. from June, 2022)

Name of the Programme : M.Sc. Statistics
Program Code : PSST
Class : M.Sc. Part – I
Semester : I
Course Name : Statistics Practical – I
Course Code : PSST115
No. of lectures : 60
Credit : 4 credits

Course Outcomes:

Students should be able to:

- **CO1** review the core topics in probability and statistics through the study and practice of data analysis and graphical interpretation using statistical software.
- **CO2** solve systems of linear equations using various methods.
- **CO3** plots different probability distributions and draw a model sample from it.
- **CO4** construct the orthogonal matrix, diagonalization of a symmetric matrix etc.
- **CO5** understand various discrete and continuous probability distributions along with their real-life applications.
- **CO6** understand the concepts of quadratic forms and solve problems.
- **CO7** explore applications of linear algebra in multivariate analysis, linear models etc.

Sr. No.	Title of Experiments
1.	Introduction to Statistical Software – I (Minitab, R, Matlab, SPSS)
2.	Matrices
3.	G-Inverse and MPG-Inverse
4.	Eigen value, Eigen vectors, Spectral decomposition, Power of matrix- I
5.	Eigen value, Eigen vectors, Spectral decomposition, Power of matrix- II
6.	Solution of system of linear equations using Gauss elimination, Gauss Jordon, Gauss Seidal and Gauss Jacobi methods
7.	Application of Calley- Hamilton Theorem
8.	Classification and reduction of quadratic forms
9.	Plotting of density function, distribution functions, computation of probability of events related to bivariate probability distribution, computation of probability of non-central χ^2, t, F-distributions
10.	Model sampling from Gamma, Chi-square, Weibull, Lognormal probability distribution

11.	Model sampling from discrete, continuous and mixture distribution
12.	Model sampling from bivariate probability distribution

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3								
CO2		3							
CO3					2				
CO4									
CO5				2					
CO6						3			
CO7							2		

Justification:

PO1 - Disciplinary Knowledge

CO1 (Weightage: 3): Reviewing core topics in probability and statistics through data analysis and graphical interpretation using statistical software directly contributes to disciplinary knowledge in statistics and data analysis.

PO2 - Critical Thinking and Problem Solving

CO2 (Weightage: 3): Solving systems of linear equations using various methods showcases critical thinking and problem-solving abilities in algebraic problem-solving.

PO3 - Social Competence

(No direct alignment observed): None of the COs strongly align with Social Competence.

PO4 - Research-related Skills and Scientific Temper

CO5 (Weightage: 2): Understanding various discrete and continuous probability distributions and their real-life applications moderately relates to research-related skills in probability theory and statistical applications.

PO5 - Trans-disciplinary Knowledge

CO3 (Weightage: 2): Plotting different probability distributions and drawing model samples moderately contributes to trans-disciplinary knowledge by integrating statistical concepts with practical implementations.

PO6 - Personal and Professional Competence

CO6 (Weightage: 3): Understanding concepts of quadratic forms and solving related problems significantly contributes to personal and professional competence by applying advanced mathematical techniques.

PO7 - Effective Citizenship and Ethics

CO7 (Weightage: 2): Exploring applications of linear algebra in multivariate analysis, linear models, etc., moderately relates to effective citizenship and ethics by applying mathematical methods responsibly in data analysis and modeling.

SYLLABUS (CBCS) FOR M.Sc. Statistics
(w. e. from June, 2022)

Name of the Programme : M.Sc. Statistics
Program Code : PSST
Class : M.Sc. Part – I
Semester : I
Course Name : Statistics Practical – II
Course Code : PSST116
No. of lectures : 60
Credit : 4 credits

Course Outcomes:

Students should be able to:

- **CO1** use statistical software for the analysis and interpretation of the outcomes.
- **CO2** estimate parameters under various sampling techniques.
- **CO3** find solutions of equations using various numerical computing methods.
- **CO4** understand different sampling survey methods and give examples of situations where these methods are useful.
- **CO5** learn R-reporting and developing own R code and use of different R packages.
- **CO6** Proficiency in applying mathematical and computational techniques for data analysis and problem-solving.
- **CO7** Ability to choose appropriate methods for interpolation, optimization, integration, and statistical analysis based on the problem at hand.
- **CO8** Enhanced critical thinking and problem-solving skills in mathematics, statistics, and computational methods.

Sr. No.	Title of Experiments
1.	Estimation of parameters in simple random sampling using SRSWR and SRSWOR
2.	Estimation of parameters in Systematic sampling
3.	PPS sampling
4.	Ratio and Regression estimates
5.	Stratified sampling (using ratio and regression)
6.	Cluster sampling with equal and unequal cluster size
7.	Two stage sampling
8.	Simultaneous Transcendental equations
9.	Bivariate Interpolation

10.	Unconstraint Optimization Techniques
11.	Computation of integral by Riemann and Riemann-Stieltjes integral
12.	Jackknife technique and Bootstrap technique

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3								
CO2				3					
CO3									
CO4					2				
CO5							2		
CO6						3			
CO7		3							

Justification:

PO1 - Disciplinary Knowledge

CO1 (Weightage: 3): Using statistical software for analysis and interpretation of outcomes directly contributes to disciplinary knowledge in statistical analysis and software utilization.

PO2 - Critical Thinking and Problem Solving

CO7 (Weightage: 3): Ability to choose appropriate methods for interpolation, optimization, integration, and statistical analysis based on the problem at hand demonstrates critical thinking and problem-solving abilities in mathematical and computational contexts.

PO3 - Social Competence

(No direct alignment observed): None of the COs strongly align with Social Competence.

PO4 - Research-related Skills and Scientific Temper

CO2 (Weightage: 3): Estimating parameters under various sampling techniques strongly relates to research-related skills, especially in sampling methodologies and statistical inference.

PO5 - Trans-disciplinary Knowledge

CO4 (Weightage: 2): Understanding different sampling survey methods and giving examples of their usefulness moderately contributes to trans-disciplinary knowledge by integrating statistical concepts with practical applications.

PO6 - Personal and Professional Competence

CO6 (Weightage: 3): Proficiency in applying mathematical and computational techniques for data analysis and problem-solving significantly contributes to personal and professional competence by demonstrating practical application skills.

PO7 - Effective Citizenship and Ethics

CO5 (Weightage: 2): Learning R-reporting, developing own R code, and using different R packages moderately relates to effective citizenship and ethics by emphasizing responsible and effective use of statistical software.