Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Autonomous

Course Structure for M.Sc. I STATISTICS

Semester	Paper Code	Title of Paper	No. of Credits
I	STAT-4101	Mathematical Analysis	4
	STAT-4102	Linear Algebra	4
	STAT-4103	Probability Distributions	4
	STAT-4104	Sampling Theory	4
	STAT-4105	Practical-I	4
	STAT-4106	Practical-II	4

SYLLABUS(CBCS) FOR M.Sc. STATISTICS (w.e.f. June, 2019)
Academic Year 2019-2020

Class : M. Sc. (Semester- I)
Paper Code: STAT-4101
Paper : I Title of Paper : Mathematical Analysis
Credit : 4 credits No. of lectures: 60

A) Learning Objectives: Students should:

1 Apply mathematical concepts and principles to perform numerical and symbolic computations.
2 Use technology appropriately to investigate and solve mathematical and statistical problems.
3 Use calculus to analyze and evaluate properties of real valued functions.
4 Have a deeper understanding of mathematical theory.
5 Be familiar with several subfields of mathematics (e.g, numerical analysis, topology, operations research).
6 Understand the concepts required for further studies in Probability Theory and Asymptotic Inference.

B) Learning Outcome:
1 Understand the fundamentals ideas and applications of calculus.
2 Employ technology to investigate mathematical concepts and applications.

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. (These concepts will be introduced through metric spaces and R^n will be considered as a special case) Compactness, Heine-Borel theorem.

(15L)

Unit-2

Sequence of real numbers, convergence and divergence of sequence, subsequences of a sequence, Cauchy sequences, Bolzano-Weierstrass theorem, 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), alternative series, conditional and absolute convergence, power series and radius of convergence, examples and problems on these concepts. **(15L)**

Unit-4

Concept and examples on Derivative of real function, mean value theorem, L' Hospital rule, Taylor's theorem, Inverse function theorem (without proof), implicit function theorem (without proof), definitions and existence of 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. Apostol T.M. (1975). Mathematical Analysis: A modern approach to advanced calculus. Addison-Wesley
2. Rudin, W. (1985). Principles of Mathematical Analysis, McGraw-Hill
3. Goldberg R.R.(1964): Methods of Real Analysis-Blaisell Publishing company, New York, U.S.A.
4. Bartle R.G. & Sherbert D.R. (2000): Introduction to Real Analysis-John Wiley & Sons Inc.
5. Bartle R. G. (1976). Elements of Real Analysis, John Wiley
6. Mapa S. K. (2018) Inroduction to Real Analysis, Sarat Book Distributors, Kolkata
7. Ghorpade, S. R. and Limaye, B. V. (2006). A Course in Calculus and Real Analysis, Springer
8. Ajit Kumar (2019), A Basic Course in Real Analysis, A Chapman & Hall Book

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Class : M. Sc. (Semester- I)
Paper Code: STAT-4102
Paper : II Title of Paper : Linear Algebra
Credit : 4 credits No. of lectures: 60

A) Learning 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 basic mathematical concepts required in advanced statistical and machine learning techniques.

B) Learning Outcome:

Students will demonstrate competence with the basic ideas of linear algebra including concepts of linear systems, independence, theory of matrices, linear transformations, bases and dimension, eigenvalues, eigenvectors and diagonalization.

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, linear transformation, algebra of matrices, row and column spaces of a matrix, elementary operations and elementary matrices, rank of a matrix. **(15 L)**

Unit-2

Inverse of a matrix null space and nullity, partitioned matrices, permutation matrix, reducible / irreducible matrix, primitive / imprimitive matrix, idempotent matrix, Kronecker product, 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

Characterstic roots of a matrix algebraic and geometric multiplicities of a characteristic root, right and left characteristic, vector, orthogonal property of characteristic vector Cayley-Hamilton theorem and its applications. **(15 L)**

Unit-4

Spectral decomposition of a real symmetric matrix singular value decomposition nth power of a matrix, Choleskey decomposition of real quadratic form, reduction and classification of 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 Bokk Company Inc.
2 . Hadely G.(1962) Linear Algebra,Narosa Publishing House.
3 . Harville D. (1997) Matrix Algebra From Statistics Perspective,Springer.
4 . Rao A.R. and Bhimasankaram P.(2000),Linear Algebra,Second edition,Hindustan Book Agency.
5 . Rao C.R. (2001) Linear Statistical Inference and Its Application,Second Edition,Wiley.
6 . Schott J. (2016) Matrix Analysis for Statistics,Third edition Wiley.
7 . Searl S.B.(2006) Matrix Algebra Useful for Statistics,Wiley.
8 . R. B. Bapat Linear Algebra and Linear Models.

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Class : M. Sc. (Semester- I)
Paper Code: STAT-4103
Paper : III Title of Paper : Probability Distributions
Credit : 4 credits No. of lectures: 60

A) Learning Objectives:

1. Providing students with a formal treatment of probability theory.
2. Understand characteristics about discrete and continuous random variable and their probability distributions.
3. Prepare students for modeling real data using distributions
4. Develop understanding of distribution theory related for further advanced topics in statistical inference.

B) Learning Outcome:

Students should be able to:

1. Develop problem-solving techniques needed to accurately calculate probabilities.
2. Apply problem-solving techniques to solving real-world events.
3. Apply selected probability distributions to solve problems.

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. **(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, multiple and partial correlation coefficient, 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) Weibull (2 and 3 parameter), 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 and 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, Fisher's Cochrans theorem, order statistic, joint distribution of order statistic, distribution of r^{th} order statistic, joint distribution of (r^{th} and s^{th} order statistic and their function), distribution of range. **(15 L)**

References:

1 Rohatgi V. K. and Saleh A. K. Md. E. (2002): An Introduction to probability and statistics, John wiley & Sons (Asia)

2 Hogg R. V. and Crag R. G. (1978): Introduction to Mathematical Statistics Ed.4.

3 Casella and Burger(2002) Statistical Inference (Duxbury advanced series II edition)

4 Johnson N.L. & Kotz S.(1996) Distributions in statistics Vol.I .VolI and Vol III John Wiley and sons Inc.)

5 Johnson N.L., Kotz S., Balkrishnan, N. Multivariate Distributions (John Wiley and sons)

6 Rohatagi V.K. & Saleh A.K.(2001) Introduction to probability theory and mathematical statistics. (John Wiley and sons)

7 Anirban DasGupta, Fundamentals of Probability: A First Course

8 Feller, Fundamentals of Probability: A First Course

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Class : M. Sc. (Semester- I)
Paper Code: STAT-4104
Paper : IV Title of Paper: Sampling Theory
Credit : 4 credits No. of lectures: 60

Learning 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 Distinguish between probability and non-probability sampling.
3 Understand the factors to consider when determining sample size.
4 Understand the steps in developing a sampling plan.
5 Handle the problem of non response or missing data.

Learning Outcomes:

Students are expected to

1 Define principal concepts about sampling
2 Explains the advantages of sampling.
3 Lists the stages of sampling process
4 Categorizes and defines the sampling methods
5 Apply the Simple Random Sampling (SRS) method
6 To analyze and solve problems
7 Use statistical softwares.

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 method, Horvitz-Thompson estimator, its variance and properties, Des Raj estimators for a general sample size and Murthy's estimator for a sample of size 2, midzuno sampling design. **[15L]**

Unit 3:

Use of supplementary information for estimation, ratio and regression estimators using separate strata and combined strata, unbiased and almost unbiased ratio type estimators of population mean post stratification, variance of estimator of population mean under it, cluster sampling with clusters of equal sizes and unequal sizes, estimator of population mean and its properties, two stage sampling with equal first stage units, expected value and variance of sample mean, double sampling. **[20L]**

Unit 4:

Sampling and non-sampling errors, Response and non response errors, mathematical model for Response errors, Hansen Hurwitz technique Randomized response technique (RRT), 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. Sukhatme P.V. Sukhatme B.V. and C. Ashok Sampling theory of survey and applications (Indian society for Agricultural statistics)
4. W.G.Cochran, (1977) Sampling techniques (John Wiley and sons)

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Class : M. Sc. (Semester- I)
Paper Code: STAT-4105
Paper : V Title of Paper: Practical-I
Credit : 4 credits No. of lectures: 60

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

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Class : M. Sc. (Semester- I)
Paper Code: STAT-4106
Paper : VI Title of Paper: Practical-II
Credit : 4 credits No. of lectures: 60

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.	Double sampling
9.	Simultaneous Transcendental equations (Theory and Procedure)
10.	Simultaneous Transcendental equations (Problems using any Software)
11.	Bivariate Interpolation
12.	Unconstraint Optimization Techniques (Theory and Procedure)
13.	Unconstraint Optimization Techniques (Problems using any Software)
14.	Computation of integral by Riemann and Riemann-Stiltjes integral
15	Jackknife technique and Bootstrap technique