

Syllabus for P.G. Diploma in Statistics/ Two-year Master's Programme in Statistics
1st - Semester for the year 2025 and onwards under NEP 2020
(Board of Postgraduate studies held on 05-05-2025)

Course Title: Sampling Techniques

Course Code: MSTSCST125

Total Number of Credits: 04

Total Contact Hours:60 hrs.

Max. Marks:100

Course Learning Objectives:

- To understand and differentiate various types of systematic sampling and evaluate their advantages, disadvantages and applications in population studies.
- To develop proficiency in cluster sampling technique and evaluate efficiency using intra-class correlation and optimum sampling units.

Course Learning Outcomes:

Upon successful completion of the course, students will be able to:

CLO 1: describe various systematic sampling methods and compute sample means and variances with comparisons to simple random and stratified sampling under general and linear trend conditions.

CLO 2: apply cluster sampling for both equal and unequal cluster sizes and evaluate efficiency using intra-class correlation and identify optimum sampling units.

CLO 3: analyse and derive ratio and regression estimators, evaluate their variances and demonstrate their efficiency in different sampling scenarios including stratified sampling.

CLO 4: execute double sampling strategies and estimate population parameters including variance computations for ratio and regression estimators in double sampling.

UNIT I

Systematic Sampling: Types of systematic sampling, advantages and disadvantages of systematic sampling. Applications of systematic sampling. Sample mean and its variances. Comparison of systematic with simple random and stratified sampling in the general case and also in the case of linear trend.

UNIT II

Cluster sampling: Estimation of mean and its variance for equal and unequal clusters. Efficiency in terms of intra-class correlation. Optimum unit of sampling. Sampling with replacement and unequal probabilities. Estimation of mean and its variance.

UNIT III

Ratio and Regression methods of Estimation: Variance of the estimates, estimation of variances, optimum property of ratio and regression estimator. Ratio and regression estimator in stratified random sampling. Comparison among regression, ratio and simple unbiased estimates. Unbiased ratio type estimates.

UNIT IV

Double Sampling: Variance of ratio and regression estimates in double sampling. Double Sampling for Stratification including estimation of variance. Sampling on successive occasions: Sampling on two occasions, estimation of current population means.

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CLO-PLO Mapping Matrix for MSTSCST125						
		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO						
	CLO1	3	2	3	3	2.75
	CLO2	3	3	2	3	2.75
	CLO3	3	3	3	3	3
	CLO4	3	2	2	3	2.5
	Average PLO	3	2.5	2.5	3	2.75

Recommended Text Books & References:

- Cochran, W. G: Sampling Techniques, 3rd edition, Wiley.
- Mukhopadhyay, P. (2000): Theory and Methods of Survey Sampling, Prentice Hall of India, Private limited, New Delhi
- Des Raj & Chandak (1998): Sampling Theory, Narosa.
- Murthy, M. N. (1977): Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
- Singh, D and Chuddar, F. S. (1986): Theory and Analysis of Sample Survey Design.
- Sirjendar Singh (2022): Advanced Sampling Theory with Applications; Springer Publishing House.

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Course Title: Advanced Probability Theory

Course Code: MSTSCAP125

Total Number of Credits: 04

Total Contact Hours: 60 hrs.

Max. Marks: 100

Course Learning Objectives:

- To understand various types of convergence for sequences of random variables
- To apply foundational probability theorems such as the Laws of Large Numbers and the Central Limit Theorem.
- To study and apply important sampling distributions such as Fisher's Z, Student's t, and non-central t-distributions,

Course Learning outcomes (CLO's)

On successful completion of this course, the students will be able to:

CLO 1: demonstrate understanding of different modes of convergence for sequences of random variables (in probability, almost sure, in distribution), and apply laws of large numbers and the Central Limit Theorem to infer limiting behaviour.

CLO 2: analyse Fisher's Z-distribution and transformation

CLO 3: apply Student's t and Fisher's t-distributions to practical problems, including derivation of their properties using moment generating functions.

CLO 4: evaluate properties of the F-distribution and its relation to t and Chi-square distributions, and understand non-central F-distributions.

UNIT-I

Convergence: Convergence of a sequence of random variables, convergence in probability, almost sure convergence of a sequence of pair of random variables. Convergence of moments. Weak law of large numbers (WLLNs): Condition for the WLLNs. Strong law of large number (SLLN) and examples, Central Limit Theorem, Cauchy-Schwartz Inequality, Chebyshev's Inequality.

UNIT-II

Fisher's Z-distribution, Fisher's Z transformation with properties and applications. Sampling distributions: Student's t distribution, Fisher's t distribution, derivation, properties and applications. Mean and variance through moment generating function, Relation of Z & t distribution with the other distributions. Non-central t-distribution: assumptions, properties and applications.

UNIT-III

F distribution: Introduction, derivation, constants, mode, point of inflexion, properties and applications. Relation of F distribution with the t and Chi-square distributions. Non-central F-distribution: assumptions, properties and applications. Bivariate distributions: Bivariate normal distribution and multinomial distributions and their properties, marginal and conditional distributions. Expectations and conditional expectations, covariance with examples.

UNIT-IV

Sampling distributions: Chi-square distribution: derivation, constants, conditions, yates' correction, grouping when individual frequency are small, properties and applications. Mean and variance through moment generating function, Limiting case and additive property of chi-square distribution. Relation of Chi-square distribution with the other related distributions. Non-central Chi-square distribution; assumptions, properties and applications.

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CLO-PLO Mapping Matrix for MSTSCAP125						
		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO	CLO 1	3	3	3	3	3
	CLO 2	3	2	2	3	2.5
	CLO 3	3	2	3	3	2.75
	CLO 4	3	3	2	2	2.5
	Average PLO	3	2.5	2.5	2.75	2.6875

Recommended Text Books & References:

- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition
- Rohatgi, V.K. (1994): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
- Dudley, R.M. (1989): Real Analysis and Probability, Wads worth and Brooks /Cole
- Pitman, J. (1993): Probability, Narosa Publishing House.
- Johnson, S. and Kotz, (1972): Distributions in Statistics, vol. III, Houghton and I, II And Miffin.
- Johnson, Kotz and Kemp (1992): Univariate discrete distribution, John Willy.
- S C Gupta (2016): Fundamental of Mathematical Statistics: S. Chand and Sons.

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Course Title: Practical Statistics-I

Course Code: MSTSCPR125

Total Number of Credits: 04

Total Contact Hours: 120 hrs.

Max. Marks:100

Practical based on MSTSCST125 and MSTSCAP125

Course Learning Objectives:

- To understand and differentiate various types of systematic sampling, and evaluate their advantages, disadvantages, and applications in population studies.
- To study and apply important sampling distributions such as Fisher's Z, Student's t, and non-central t-distributions,

Course Learning Outcomes (CLO's)

On successful completion of this course, the students will be able to

CLO 1: Compute sample means and variances, with comparisons to simple random and stratified sampling using data sets.

CLO 2: compute sample means and variances of double sampling.

CLO 3: apply Student's t and Fisher's t-distributions to practical problems.

CLO 4: apply F-distribution, t and Chi-square distributions to practical problems

CLO-PLO Mapping Matrix for MSTSCPR125

CLO		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
	CLO1	3	3	3	3	3
	CLO2	2	2	3	3	2.5
	CLO3	2	2	3	3	2.5
	CLO4	3	3	3	3	3
Average PLO		2.5	2.5	3	3	2.75

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Course Title: Research Methodology and Scientific Instrumentation

Course Code: MSTSDRM125

Total Number of Credits: 04

Total Contact Hours: 60 hrs.

Max. Marks: 100

Course Learning Objectives:

- To make the students understand the fundamental approaches of Research.
- To acquaint the students with necessary understanding and skills of carrying out Research.

Course Learning Outcomes (CLO's)

CLO 1: The course is expected to augment the research capabilities of the students while sharpen their data collection, analysis and presentation skills.

CLO 2: To enhance the data analysis and report writing skills of the students

CLO 3: The course is designed to fashion the students into good ethical researchers and enhance their abilities to carrying out independent research projects.

CLO 4: To enhance the data analysis and publication ethics of the students.

UNIT-I

Defining & Refining the Research Problem: Preliminary Research & Problem Statement. Questions of problem statement: Exploratory, Descriptive and Casual research Questions. Process of formulating research problem. Framing of research objectives. Research Design: Meaning, Importance & Elements. Research Designs: Experimental Design, Cross-Sectional Design, Longitudinal Design, Comparative Design & Case Study Design.

UNIT-II

Variables: Dependent & Independent Variables. Operationalization of Variables: Dimensions & Elements. Hypotheses Development: characteristics & functions. Level of Measurement, Types of hypotheses. Testing of hypotheses. Errors in testing hypotheses. One Tailed and Two Tailed Test of Significance. Parametric and Nonparametric Tests of Univariate and Bivariate Data, factor analysis, Principal Component analysis.

UNIT-III

Data Collection. Primary Data: Sources, Advantages & Disadvantages. Secondary Data: Sources, Advantages & Disadvantages. Ethical issues in data collection. Sampling: Principles, Aims & Process, Sample Size Determination, Types of Probability Sampling: Simple Random, Systematic Sampling, Stratified Random Sampling, & Multi-stage Cluster Sampling. Non-Probability Sampling: Convenience Sampling & Quota Sampling. Research Report: Purpose & Audience. Characteristics of well-written research report. Contents of research report.

UNIT-IV

Publication Ethics: definition, introduction and importance, Conflict of interest, Publication misconduct: definition, concept, problems that lead to unethical behavior and vice-versa, types, Violation of publication ethics, authorship and contributor ship, Databases: Indexing databases, Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact factor of journal as per journal citation report, SJR, Cite Score. Metrics: h-index, g index, i10 index.

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CLO-PLO Mapping Matrix for MSTSDRM125						
		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO	CLO1	3	2	2	3	2.5
	CLO2	2	3	2	3	2.5
	CLO3	3	3	3	3	3
	CLO4	3	2	3	3	2.75
Average PLO		2.75	2.5	2.5	3	2.6875

Recommended Text Books & References:

- Bhandarkar, P.L. & Wilkinson, T.S. (2016). Methodology and Techniques of Social Research. Himalaya Publishing House, Mumbai.
- Elhance, D.N., Elhance V. & Aggarwal, B.M. (2018). Fundamentals of Statistics. Kitab Mahal, Mumbai.
- Ferber, R. & Verdoon, P.J. (1962). Research Methods in Economics and Business. Macmillan, New York.
- Ghosh, B.N. (2015). Scientific Method and Social Research. Sterling Publishers, New Delhi.
- Goode, W.J. & Hatt, P.K. (2022). Methods in Social Research. McGraw Hill, London.
- Garg. B. L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers
- Gujarati, D., Porter, D.C. & Pal, M. (2017). Basic Econometrics. Tata McGraw Hill, New Delhi.
- Gupta, S.P. (2021). Statistical Methods. S. Chand & Company, New Delhi.
- Kothari, C.R. & Garg, G. (2019). Research Methodology: Methods and Techniques. New Age International Publishers, New Delhi.
- Kurien, C.T. (1973). Research Methodology in Economics. Sangam Publishers, Madras.
- Moser, C.A. & Kolton, C. (1979). Survey Methods in Social Investigation. Heinemann Educational Books, London.

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Course Title: Mathematical Methods for Statistics

Course Code: MSTSDMM125

Total Number of Credits: 04

Total Contact Hours: 60 hrs.

Max. Marks:100

Course Learning Objectives:

- To understand and apply the algebra of matrices, and use the Cayley-Hamilton theorem for practical applications.
- Gain foundational knowledge of set theory and real analysis concepts and understand key inequalities like Cauchy-Schwartz and Chebyshev's.

Course Learning Outcomes (CLO's)

On successful completion of this course, the students will be able to:

CLO 1: Perform matrix operations and demonstrate understanding of matrix types ,compute inverses of square and partitioned matrices,

CLO 2: Solve systems of linear equations (homogeneous and non-homogeneous), and analyze vector spaces,

CLO 3: Differentiate between finite, countable, and uncountable sets; understand the completeness of real numbers; and test the convergence/divergence of sequences and

CLO 4: Analyse functions of one real variable for limits, continuity (including uniform continuity), and differentiability.

UNIT-I

Algebra of Matrices, trace of a matrix, $\text{tr}(AB) = \text{tr}(BA)$, types of matrices: symmetric, skew symmetric, Hermitian, Skew-Hermitian, idempotent, nilpotent, orthogonal and Unitary matrices. Inverse of square matrix, Inverse of partitioned matrices. Rank of matrix, characteristic and minimal equation, Cayley-Hamilton Theorem and its Applications. Eigen values and Eigen vectors.

UNIT-II

Linear equations, solution of homogenous and non-homogenous equations. Vector spaces, basis and dimensions. Linear Transformations and their matrix representation. Inner product spaces, orthogonal and orthonormal basis. Quadratic forms, reduction and classification of quadratic forms.

UNIT-III

Finite, countable and uncountable sets, bounded and unbounded sets, Archimedean property, ordered field, completeness of $\mathbb{R}$, sequence and series, limit supremum and limit infimum of a bounded sequence. Convergence and divergence of positive term series, comparison, root and ratio tests for the convergence of series. Cauchy-Schwartz Inequality, Chebyshev's Inequality.

UNIT-IV

Limit, Continuity, uniform continuity of functions of one variable, the algebra of continuous functions, monotonic functions, types of discontinuities, infinite limits and limits at infinity. Differentiability, Rolle's Theorem, Mean Value Theorems, Riemann sum and integral (simple problems).

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CLO-PLO Mapping Matrix for MSTSDMM125						
		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO	CLO1	3	2	2	3	2.5
	CLO2	2	3	2	3	2.5
	CLO3	3	3	3	3	3
	CLO4	2	2	2	3	2.25
Average PLO		2.5	2.5	2.25	3	2.5625

Recommended Text Books & References:

- Grabill, Walter(1976). Matrices with Applications in Statistics, 2nd Ed.Wadsworth.
- Roa,C.R.(1973), Linear Statistical Inference and its Applications, 2nd Ed.John Wileyand Sons,Inc.
- Searel, S.R.(1982).Matrix Algebra useful for Statistics. John Wiely and Sons,Inc.
- Aziz, A, Rather, N.A. and Zargar, B.A.: Elementary Matrix Algebra, KBD(Kashmir Book Depo)
- Shanti Narayan, A text book of matrices, Narosa Publ. linear independence and linear dependence of row (column) vectors.
- Apostol, T.M (1985), Mathematical Analysis, Narosa, India Ed.
- Courant, R.and John, F.(1965), Introduction to Calculus and Analysis, Wiley. S.C.Malik, Mathematical Analysis, New Age International Limited.
- Miller, K.S(1975)Advanced Real Calculus, Harper, New York.
- Rudin, Walter(1976). Principles of Mathematical Ananlysis, McGraw Hill.

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Course Title: Statistical Computing Using Minitab

Course Code: MSTSDSC125

Total Number of Credits: 04

Total Contact Hours: 60 hrs.

Max. Marks:100

Course Learning Objectives:

- To learn data analysis using MINITAB.

Course Learning Outcomes (CLO's)

After successful completion of this course, the students will be able to:

CLO 1: study large number of real data sets.

CLO 2: apply the Minitab for statistical data analysis and graphics.

CLO 3: find solutions of problems of optimization through Minitab.

CLO 4: transfer textbook knowledge to practical situations.

UNIT-I

Reading and Manipulation of data, Commands/Statements in MINITAB, Descriptive Statistics. Working with Software package MINITAB for graphics, EDA: Histogram, Plot, Box plot, Pi-chart, QQ plot, density plot, and Stem and Leaf.

UNIT-II

Basic operations on matrices. Correlation and Regression analysis: simple and multiple. Test of significance of large samples, Test of single proportion, Test of significance of difference of proportions.

UNIT-III

Chi-Square test for independence of attributes and Contingency table, t-test, Paired t-test, Test for correlation in sampling from normal population, F-test, testing of two variances of two univariate normal population.

UNIT-IV

Analysis of Variance: One way and two-way classification, Multiple comparisons: Least Significant difference (LSD), Tukey's Test, generalized linear models: main effects and interaction of 2^2 and 2^3 factorial experiments.

CLO-PLO Mapping Matrix for MSTSDSC125

CLO-PLO Mapping Matrix for MSTSDSC125						
		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO	CLO1	3	2	2	3	2.5
	CLO2	3	3	3	3	3
	CLO3	3	3	3	3	3
	CLO4	3	3	2	3	2.75
Average PLO		3	2.75	2.5	3	2.8125

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Recommended Text Books & References:

- B. Ryan and B.L. Joiner (2001). MINITAB Handbook, Fourth edition, Duxbury.
- R.A. Thisted (1988): Elements of Statistical Computing, Chapman and Hall.
- S.C. Gupta & V.K. Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics,

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Course Title: Statistical Learning

Course No: MSTSDSL125

Total Number of Credits: 04

Total Contact Hours: 60 hrs.

Max. Marks:100

Course Learning Objectives:

- To learn the foundational concepts of statistical learning and data visualization.

Course Learning Outcomes (CLO's)

After successful completion of this course, the students will be able to:

CLO 1: equip students with the skills to summarize, explore, and visualize univariate and bivariate data effectively.

CLO 2: provide an understanding of supervised and unsupervised learning frameworks and the bias-variance trade-off.

CLO 3: develop the ability to model data using linear and multivariate normal models.

CLO 4: introduce Bayesian principles in statistical modelling and regularization techniques.

UNIT I

Importing, Summarizing, and Visualizing data: introduction, Structuring Features According to Type, Summary Tables, Summary Statistics, Visualizing Data, Plotting Quantitative Variables: Boxplot, Histogram, Empirical Cumulative Distribution Function.

UNIT II

Data Visualization in a Bivariate Setting: Two-way Plots for Two Categorical Variables, Plots for Two Quantitative Variables, Plots for One Qualitative and One Quantitative Variable.

UNIT III

Statistical Learning: Introduction, Supervised and Unsupervised Learning, Training and Test Loss, Trade-offs in Statistical Learning, Estimating Risk, In-Sample Risk, Expected Optimism, Cross-Validation, Modelling Data, Linear Model.

UNIT IV

Multivariate Normal Models: Multivariate Normal Distribution, Density of a Multivariate Random Vector, Normal Linear Models, Bayesian Learning: Prior, Likelihood, and Posterior, Bayesian Regularization of Maximum Likelihood, Approximating the Bayesian Cross-Entropy Risk.

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CLO-PLO Mapping Matrix for MSTSDSL125						
		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO	CLO1	3	3	2	3	2.75
	CLO2	3	3	3	3	3
	CLO3	3	2	3	3	2.75
	CLO4	3	2	2	3	2.5
Average PLO		3	2.5	2.5	3	2.75

Recommended Text Books & References:

- Dirk P. Kroese, Zdravko I. Botev, Thomas Taimre, Radislav Vaisman (2024): Data Science and Machine Learning: Mathematical and Statistical Methods. CRC Press.
- Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani (2021): An Introduction to Statistical Learning with Applications in R (2nd Edition). Springer.
- Trevor Hastie, Robert Tibshirani, Jerome Friedman (2009): The Elements of Statistical Learning: Data Mining, Inference, and Prediction (2nd Edition). Springer.
- Trevor Hastie, Robert Tibshirani, Martin Wainwright (2015): Statistical Learning with Sparsity: The Lasso and Generalizations. CRC Press.
- Shai Shalev-Shwartz, Shai Ben-David (2014): Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press.

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