

Syllabus for P.G. Diploma in Statistics/ Two-year Master's Programme in Statistics
2nd - Semester for the year 2025 and onwards under NEP 2020
(Board of Postgraduate studies held on 05-05-2025)

Course Title: Statistical Inference – I

Course Code: MSTSCSI225

Total No. of credits: 04

Total Contact Hours: 60 hrs.

Max. Marks:100

Course Learning objectives:

- To equip students with a comprehensive understanding of the theoretical foundations and practical methodologies of statistical inference.

Course Learning Outcomes (CLO's)

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

CLO 1: understand estimation problems including point and interval estimation

CLO 2: evaluate estimators using key properties such as unbiasedness, consistency, efficiency, and sufficiency.

CLO 3: using factorization and Fisher-Neyman criteria, and understand their role in statistical estimation.

CLO 4: apply various estimation methods including method of moments, maximum likelihood estimation (MLE), and minimum chi-square techniques, and assess their properties.

UNIT-I

Statistical Inference: Problems of estimation and point Estimation, the general statistical decision problem, Example (Point estimation, Interval estimation etc.). Criteria of unbiasedness, consistency and efficiency. Chapman Robin's Inequality, Cramer-Rao Inequality. Minimum variance unbiased (MVU) estimation, UMVU Estimation, Asymptotic relative efficiency, Invariance of consistent estimator under continuous transformation.

UNIT-II

Sufficient and Complete Statistics: Sufficiency, Minimal sufficient statistic, Factorization theorem, Fisher–Neyman criterion. Characterization of distributions. Admitting Sufficient Statistics. Exponential families and Pitman families, Invariance property of sufficiency under one-to-one transformation of sample space. Fisher information for one and several parameter models. Rao-Blackwell theorem. Completeness and Lehman –Scheffle theorem.

UNIT-III

Methods of estimation: Method of Moments, Method of Maximum Likelihood estimation (MLE). Optimum properties of MLE. Maximum Consistent Asymptotic Normal estimators (CAN) obtained by MLE method in one parameter exponential family. Minimum Chi –square, modified Chi –square and least square method of estimation .

UNIT-IV

Interval Estimation: Determination of confidence interval based on small sample. Determination of confidence interval based on large samples. Relation between confidence estimation and hypothesis testing. Bayesian Interval estimation.

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CLO-PLO Mapping for MSTSCSI225						
		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO	CLO1	3	3	3	3	3
	CLO2	3	2	2	3	2.5
	CLO3	3	3	3	3	3
	CLO4	3	3	3	3	3
	Average PLO	3	2.75	2.75	3	2.875

Recommended Text Books & References:

- Kale, B.K. (1999): A first course on Parametric Inference, Narosa Publishing House.
- Rohatgi, V. (1988): An Introduction to Probability and Mathematical Statistics. Wiley Eastern Ltd. New Delhi (Student Edition)
- Lehman, E.L. (1986): Theory of Point Estimation (Student Edition)
- Lehman, E.L. (1986): Testing Statistical Hypothesis (Student Edition)
- Rao, C.R. (1973): Linear Statistical Inference
- Dudewicz, E.J. and Mishap, S.N. (1988): Modern Mathematical Statistics. Wiley Series in Prob. Math. Stat., John Wiley and Sons, New York (International Student Edition)
- Ferguson, T.S. (1967): Mathematical Statistics, Academic.
- Zacks, S (1971). Theory of Statistical Inference, John Wiley and Sons, New

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Course Title: Linear Models and Regression Analysis

Course Code: MSTSCLM225

Total No. of credits: 04

Total Contact Hours: 60 hrs.

Max. Marks:100

Course Learning Objectives:

- To provide thorough understanding of linear models and their applications in statistical inference. The course focuses on estimation and hypothesis testing within the framework of the Gauss-Markov theorem,

- **Course Learning Outcomes (CLO's)**

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

CLO 1: understand the Gauss-Markov setup and apply the method of least squares for parameter estimation in linear models.

CLO 2: classify and analyse different linear models including those with full rank and those not of full rank.

CLO 3: formulate and test linear hypotheses using F-tests and t-tests, and construct confidence and prediction intervals in parametric settings.

CLO 4: perform analysis of covariance (ANCOVA) and interpret results in one-way and two-way models involving covariates.

UNIT-I

Linear models; Gauss Markov set up, Model classification, Normal equations and least squares estimates, Error and estimation space, Variance and covariance of least square estimates, Estimation of error variance, estimation with correlated observations, least square estimates with restriction on parameters.

UNIT-II

Models not of full rank; Normal equations, Consequences of solutions and estimation and estimating parameters. Distribution properties, estimable functions and properties of estimable functions. Mixed effect models and its estimation

UNIT-III

Test of hypotheses for one and more than one linear parametric functions, Tests of linear hypotheses, estimable linear hypotheses, confidence intervals and prediction intervals, Generalized F test, generalized t test.

Experimental Design models; Introduction, point estimation, Re-parameterization, Variance and Covariance of estimable function, testing of hypotheses, Regression models.

UNIT-IV

Simple linear and multiple regression fit of polynomials, Residual and their plot as tests for departure from assumption such as fitness of model, normality, and homogeneity of variances and detection of outliers, Analysis of covariance, estimation and testing, one way model with one covariance, two-way model with two covariance.

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CLO-PLO Mapping for MSTSCLM225						
		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO						
	CLO1	3	3	3	3	3
	CLO2	3	2	2	3	2.75
	CLO3	3	2	3	3	2.75
	CLO4	2	2	2	3	2.25
	Average PLO	2.75	2.25	2.75	3	2.6875

Recommended Text Books & References:

- Cookers.and Weisberg, S (1982). Residual and Influence in Regression. Chapman and Hall
- Draper,N.R. and Smith, R.L. (1998). Applied Regression Analysis.3rd Ed. Wiley.
- Gunst, R.F. and Mason, R.L. (1980). Regression Analysis and its Applications- A Data Oriented Approach. Marcel and Decker.
- Roa, C.R. (1973). Linear Statistical Inference and its Applications. Wiley Eastern.
- Weisberg, S. (1985). Applied Linear Regression.Wiley.
- Rencher,A.C And Schaalje,G.B(2007),Linear Model in Statistics, John Wiely and Sons
- Graybill, Franklin A (1961): An introduction to linear statistical models, New York : McGraw-Hill

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Course Title: Practical Statistics-II

Course Code: MSTSCPR225

Practical based on MSTSCSI225 and MSTSCLM225

Total No. of credits: 04

Total Contact Hours: 120 hrs.

Max. Marks:100

Course Learning Objectives:

- Apply various estimation methods for real data sets.
- The course focuses on estimation and hypothesis testing within the framework of the Gauss-Markov theorem,

Course Learning Outcomes (CLO's)

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

CLO 1: Apply various estimation methods including method of moments, maximum likelihood estimation (MLE), and minimum chi-square techniques in real data sets.

CLO 2: formulate and test linear hypotheses using F-tests and t-tests in real data sets.

CLO 3: construct confidence and prediction intervals in parametric settings in real data sets

CLO 4: perform analysis of covariance (ANCOVA) and interpret results in one-way and two-way models involving covariates in real data sets.

CLO-PLO Mapping for MSTSCPR225						
		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO	CLO1	3	3	3	3	3
	CLO2	3	3	3	3	3
	CLO3	3	2	3	3	2.75
	CLO4	2	3	2	3	2.50
	Average PLO	2.75	2.75	2.75	3	2.8125

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Course Title: Operations Research for Decision Making

Course Code: MSTSDOR225

Total No. of credits: 04

Total Contact Hours: 60 hrs.

Max. Marks:100

Course Learning objectives:

- To introduce theory and applications of Operations Research techniques with a focus on linear programming, duality, game theory, sequencing, and scheduling,

Course Learning Outcomes (CLO's)

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

CLO 1: formulate and solve Linear Programming Problems (LPPs) using graphical and algebraic methods

CLO 2: understand the theory of duality in LPPs and apply theorems such as Weak and Strong Duality, Complementary Slackness, and Dual Simplex Method to solve optimization problems.

CLO 3: apply game theory concepts including maximin and minimax strategies, pure and mixed strategies, and dominance principles

CLO 4: apply PERT and CPM techniques to project management, including network construction, time analysis (ES, EF, LS, LF), float calculation, project completion probabilities, and project crashing for time-cost trade-offs.

UNIT I

Review of Linear programming problems (LPP): Formulation of Linear programming problems (LPP), Canonical and standard form of LPP. Methods of solving LPP: Simplex method, Big-M method, Two-phase method and Extreme point theorems; Revised Simplex Method, Assignment Problems, Hungarian method.

UNIT II

Duality in Linear programming problem. Relationship between Primal and Dual LPP. Weak duality theorem, Optimality criterion theorem, Unboundedness theorem, Fundamental theorem of duality, Complementary Slackness theorem and Complementary Slackness conditions and their applications. Dual Simplex Method.

UNIT III

Introduction to game theory. Strategy and its types. Decision Making in the face of competition, payoff matrix, two-person zero sum games, Maximin and Minimax principle. Games with pure and mixed strategies, existence of solution and uniqueness of value in zero-sum games, finding solutions of 2x2 payoff matrices. Dominance principle, finding solutions of 2 x m and mx2 type games, Equivalence between game theory and linear programming problem.

UNIT IV

Sequencing and scheduling problems: 2 machine n-job; 3 machine n-job problems with identical machine sequence for all jobs; 2-job n-machine problem with different routings. Project management; PERT and CPM; rules of network construction, determination of ES and EF times, determination of LS and LF times, determination of float. Probability of project completion. Project Crashing.

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		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO	CLO1	3	3	3	3	3
	CLO2	3	3	3	3	3
	CLO3	3	3	3	3	3
	CLO4	2	2	2	3	2.25
	Average PLO	2.75	2.75	2.75	3	2.8125

Recommended Text Books & References:

- Taha H.A. (1982) Operational Research: An introduction; Macmillan.
- Philips D.T., Ravindran A. and Solberg J. Operation Research, Principles and Practice.
- Kanti Swarup, P.K. and Singh, M.M.. (1985) Operation Research; Sultan Chand & Sons.
- Churchman C.W, Ackoff R.L. and Arnoff E.L. (1957) Introduction to Operations Research
- R. Panneerselvam(2002): Operations Research: Prentice Hall
- S D Shrama (2014): Operations Research (Theory Methods & Applications)

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Course Title: Statistics with R

Course Code: MSTSDSR225

Total No. of Credits: 04

Total Contact Hours: 60 hrs.

Max. Marks:100

Course Learning Objectives:

- The course is developed to help the students to learn various advanced techniques of data analysis in R Software.

Course learning Outcomes (CLO's)

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

CLO 1: have full knowledge of R software.

CLO 2: find solutions of problems of optimization through R.

CLO 3: articulate statistical modelling using R.

CLO 4: apply these modelling tools in statistical learning.

UNIT-I

Introduction to R language, R as a calculator, vectorization, notation and naming. Creation of data object, vector, factor and data frame. Extraction operators in R, data import/export, manipulation of data, summary of data and statistical graphics with R. Representation of multivariate data in R.

UNIT-II

Managing matrices in R: creating matrices, adding on to matrices, adding attributes to matrices, sub-setting matrices. Correlation and regression analysis in R. Tests of significance, test of single proportion, test of significance for difference of proportions.

UNIT-III

Using R software's: Chi-Square tests: The Chi-square distribution: Chi-squared goodness of fit tests, Chi-squared tests of independence and Chi-squared tests of homogeneity of variance. t-test for single mean, difference of means and paired t-test. F-test: testing of two variances of two univariate normal population.

UNIT-IV

Simulation studies using R software, random number generation of various probability distributions. Codes for different programmes in R-software. Estimation of parameters of different probability functions by using R. Linear programming with R. Optimization with R.

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CLO-PLO Mapping for MSTSDSR225						
		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO						
	CLO1	3	2	3	3	2.75
	CLO2	3	3	3	3	3
	CLO3	3	3	3	3	3
	CLO4	2	3	2	3	2.5
	Average PLO	2.75	2.75	2.75	3	2.8125

RECOMMENDED TEXT BOOKS & REFERENCES:

- Bradley C. Boehmke (2016): Data Wrangling with R. Springer.
- E.J. Dudewicz and S.N. Mishra. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition.
- John Verzani. (2005): Using R for Introductory Statistics. Chapman & Hall/CRC.
- S.C. Gupta and V.K. Kapoor (2012): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
- Michael J.Crawley (2007): The R book: Wiley.

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Course Title: Data Analysis Using SPSS

Course Code: MSTSDDA225

Total No. of Credits: 04

Total Contact Hours: 60 hrs.

Max. Marks:100

Course Learning Objectives:

- The objective of this course is to equip students with foundational knowledge and practical skills in statistical data analysis.
- Aims to develop the ability to interpret data, test assumptions, and make informed decisions using appropriate statistical tools.

Course Learning Outcomes:

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

CLO 1: construct and interpret various graphical representations and compute summary statistics

CLO 2: Apply linear regression techniques to model and predict outcomes based on explanatory variables.

CLO 3: demonstrate understanding of hypothesis testing and post hoc multiple comparisons.

CLO 4: describe and use basic probability distributions while checking assumptions of normality using appropriate plots.

UNIT I

Graphical Representation of Data- Bar Charts, Stacked Bar, Histogram, Line diagram, Pie diagram, Box Plot, Exporting Graphs, Summary Statistics; Mean, Median, Standard Deviation, Standard Error.

UNIT II

Correlation Analysis: Scatter plot, Karl Pearson's, Spearman's and Partial correlation. Regression Analysis: Introduction to linear models. Simple linear regression involving two variables, Multiple and Partial Regression.

UNIT III

Basic concepts of Testing (hypothesis, types of errors, power, critical value, level of significance), concept of p-value, one-sample t test, independent t-test, paired t-test, one way &, two-way ANOVA, Multiple Comparisons, Confidence Interval for means.

UNIT IV

Basic distributions (Binomial, Poisson, Normal, Exponential etc.) Generating random samples from these distributions. Parametric Tests: Normal Probability curve, checking normality assumption using histogram, box plot and quantile (Q-Q) plots. Odd's and Relative risk, Chi-square test, Custom tables, Fisher's Exact Test.

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CLO-PLO Mapping for MSTSDDA225						
		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO						
	CLO1	3	2	2	2	2.25
	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	2.75	2.75

Recommended Books & References:

- 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, Willy, Int'l Students edition.
- Ajai Gaur, S. Statistical methods for practice & research: a guide to data analysis using SPSS

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Course Title: Data Science

Course Code: MSTSDDS225

Total Contact Hours: 60 hrs.

Total No. of Credits: 04

Max. Marks:100

Course Learning Objectives:

- Develop an understanding of data collection strategies and data preprocessing techniques.
- Equip students with skills in exploratory data analysis using statistical and visualization tools.

Course Learning Outcomes (CLO's)

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

CLO 1: describe the evolution of Data Science and identify key roles and real-world applications, including awareness of data security issues.

CLO 2: apply data collection and preprocessing methods, including cleaning, integration, transformation, and discretization.

CLO 3: conduct exploratory data analysis (EDA) using descriptive statistics, box plots, pivot tables, heat maps, and correlation techniques.

CLO 4: assess model performance using in-sample and out-of-sample metrics, cross-validation, ridge regression, and grid search for parameter tuning.

UNIT I

Introduction to Data Science, Evolution of Data Science ,Data Science Roles – Stages in a data science Project, Applications of Data Science in various fields, data Security Issues. Data Collection and data pre-processing data collection strategies, data pre-processing

UNIT II

Overview: Data Cleaning, data Integration and transformation, data reduction, data discretization. Exploratory Data Analytics descriptive statistics – Mean, Standard Deviation, Skewness and Kurtosis, Box Plots, Pivot table, Heat Map, Correlation Statistics, ANOVA.

UNIT III

Model development simple and multiple Regression: Model evaluation using visualization – residual plot. Distribution plot , Polynomial Regression and Pipelines, Measures for In-sample Evaluation, Prediction and Decision Making.

UNIT IV

Model Evaluation Generalization Error :Out-of-Sample Evaluation Metrics , Cross Validation – Overfitting, Under Fitting and Model Selection .m Prediction by using Ridge Regression. Testing Multiple Parameters by using Grid Search.

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CLO-PLO Mapping for MSTSDDS225						
		PLO				Average CLO
		PLO1	PLO2	PLO3	PLO4	
CLO						
	CLO1	3	3	2	2	2.5
	CLO2	3	2	3	3	2.75
	CLO3	3	2	3	3	2.75
	CLO4	3	3	2	3	2.75
	Average PLO	3	2.55	2.5	2.75	2.6875

Recommended Books & References:

- Jojo Moolayil, “Smarter Decisions: The Intersection of IoT and Data Science”, PACKT, 2016.
- Cathy O’Neil and Rachel Schutt , “Doing Data Science”, O'Reilly, 2015.
- David Dietrich, Barry Heller, Beibei Yang, “Data Science and Big data Analytics”, EMC 2013
- Raj, Pethuru, “Handbook of Research on Cloud Infrastructures for Big Data Analytics”, IGI Global.