Syllabus for Two-year Master's Programme in Statistics
3rd- Semester for the year 2025 onwards under NEP 2020
(Board of Postgraduate studies held on 05-05-2025)

Course Title: Design and Analysis of Experiments

Course Code: MSTSCDE325 **Total Number of Credits: 04**

Total Contact Hours:60 hrs. **Max. Marks:100**

Course Learning Objectives:

- To introduce the elementary and advanced concepts of design and analysis of experiments.

Course Learning Outcomes (CLO's)

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

CLO 1: describe the techniques of design of experiments in real life scenario.

CLO 2: apply the Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) to real life data sets

CLO 3: apply the response surface methodology in different application areas like food science, quality improvement, etc.

CLO 4: apply the factorial experiments to real life data sets.

UNIT-I

Planning of experiment: Nomenclature, Introduction to basic designs and their analysis, Principles of experimental design. Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), missing plot techniques for RBD and LSD.

UNIT II

Analysis of co-variance: Introduction, Analysis of co-variance model, normal equations, assumptions. Analysis of Covariance for Completely Randomized Design (CRD), Analysis of co-variance of Randomized Block Design (RBD) and Latin Square Design (LSD).

UNIT-III

Introduction to Incomplete block design intra block analysis (estimability), estimates of estimable linear parametric function; Balanced Incomplete Block Design. Intra block analysis, recovery of inter block information.

UNIT IV

General factorial experiments, factorial effects; best estimates and testing the significance of factorial effects; study of 2 and 3 factorial experiments in randomized blocks; Confounding, complete and partial confounding. Fractional replication for symmetric factorials.

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CLO-PLO Mapping Matrix for MSTSCDE325						
		PLO				**Average CLO**
CLO		PLO1	PLO2	PLO3	PLO4	
	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**	**2.625**

Recommended Text Books & References:

- Alokdey (1986): Theory of Block Designs, Willey Eastern
- Angela Dean Daniel Voss (1999): Design and Analysis of Experiments, Springer.
- Das, M.N and Giri, N. (1979): Design and Analysis of Experiments, Willey Eastern
- Giri, N (1986): Analysis of Variance, South Asia Publishers
- John, P.W.M. (1971): Statistical Design and Analysis of Experiments,
- Mcmillain Joshi. D.D. (1987): Linear estimation and Design of Experiments Willey Eastern
- R. Rangaswamy (2005): A Text book of Agricultural Statistics. New Age International (P) Limited.

Syllabus for Two-year Master's Programme in Statistics
3rd- Semester for the year 2025 onwards under NEP 2020
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Course Title: Statistical Inference-II

Course Code: MSTSCSI325 **Total number. of Credits: 04**

Total Contact Hours:60 hrs. **Max. Marks:100**

Course Learning Objectives: To introduce the advanced concepts of statistical inference.

Course Learning Outcomes (CLO's)

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

CLO 1: describe the concepts of testing of hypothesis and NP Lemma.

CLO 2:understand the concepts of MP and UMP tests.

CLO 3: describe the concepts of LRT and SPRT.

CLO 4: apply the statistical inference tools in real data analysis.

UNIT-I

Testing of Hypothesis: Concepts of critical regions, test functions, two kinds of errors, size function, power function, level of significance, Most Powerful (MP) and uniformly most powerful (UMP) test, in class of size tests. Neyman Pearson Lemma, Most Powerful tests for simple null against simple alternative hypothesis. Examples based on two kinds of errors. Applications of Neyman Pearson Lemma.

UNIT-II

Uniformly most powerful (UMP) tests for simple null hypothesis against one-sided alternatives and for one-sided null against one-sided alternatives in one parameter exponential family. Extension of these results to distributions with Monotone Likelihood ratio (MLR) property.

UNIT-III

Uniformly Most Powerful Unbiased Tests, similar tests with Neyman structure locally best unbiased tests, type A and A1 critical regions for the exponential family.

Likelihood ratio tests: Large sample properties, derivation of common likelihood ratio tests, asymptotic distribution of likelihood ratio test. Applications of likelihood ratio test.

UNIT-IV

Sequential Analysis: Definition of Sequential Probability Ratio Test (SPRT). Fundamental relations among alpha, beta, A and B. Determination of A and B in practice. Wald's fundamental identity and the derivation of O.C and ASN functions. Proof of the ultimate termination of SPRT for simple hypothesis. Applications based on Normal, Poisson, Binomial and Exponential distributions.

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CLO-PLO Mapping Matrix for MSTSCSI325						
		PLO				**Average CLO**
CLO		PLO1	PLO2	PLO3	PLO4	
	CLO1	3	2	3	3	**2.75**
	CLO2	2	3	3	3	**2.75**
	CLO3	3	3	3	3	**3**
	CLO4	3	2	3	3	**2.75**
	Average PLO	**2.75**	**2.5**	**3**	**3**	**2.81**

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 Edit
- Ferguson, T.S. (1967): Mathematical Statistics, Academic.
- Zacks, S (1971). Theory of Statistical Inference, John Wiley and Sons, New York.

Syllabus for Two-year Master's Programme in Statistics
3rd- Semester for the year 2025 onwards under NEP 2020
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Course Title: Practical Statistics-III

Course Code: MSTSCPR325

Practical based on MSTSCDE325 and MSTSDSI325

Total Contact Hours:120 hrs.

Max. Marks:100

Course Learning Objectives

- To apply elementary and advanced concepts of design and analysis of experiments in practical problems.
- To apply the advanced concepts of statistical inference in practical problems.

Course Learning Outcomes (CLO's)

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

CLO 1: Apply the Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) to real life data sets

CLO 2: Apply the response surface methodology in different application areas like food science, quality improvement, etc.

CLO 3: Apply LRT and SPRT in real life data sets.

CLO 4: Apply the statistical inference tools in real data analysis.

CLO-PLO Mapping Matrix for MSTSCPR325						
		PLO				**Average CLO**
CLO		PLO1	PLO2	PLO3	PLO4	
	CLO1	3	3	3	2	**2.75**
	CLO2	3	3	3	3	**3**
	CLO3	3	3	3	3	**3**
	CLO4	3	3	2	3	**2.75**
	Average PLO	**3**	**3**	**2.75**	**2.75**	**2.875**

Syllabus for Two-year Master's Programme in Statistics
3rd- Semester for the year 2025 onwards under NEP 2020
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Course Title: Advanced Operations Research

Course Code: MSTSDAO325 **Total number of Credits: 04**

Total Contact Hours:60 hrs. **Max. Marks:100**

Course Learning Objectives:

- To introduce the advanced concepts of Operations Research
- To equip the students with the techniques which provide solutions to real world problems which are Non-Linear in nature.

Course Learning Outcomes (CLO's)

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

CLO 1: Describe the technique of integer programming.

CLO 2: Understand the concepts of nonlinear programming.

CLO 3: Understand the concepts of quadratic programming problems.

CLO 4: Understanding the inventory control and queuing models

UNIT I

Integer Programming: Gomory's Cutting plane algorithm & branch and bounded method for all integer and mixed integer, Dynamic Programming: Single additive constraint; additive separable return, single multiple constraints; additive separable returns, single additive constraints; multiple separable returns.

UNIT II

Nonlinear Programming: Formulation, Lagrangian multiplier technique, Kuhn-Tucker necessary and sufficient conditions for optimality of an NLPP, constraint multivariable optimization with inequality constraints. Quadratic programming problems: Wolfe's and Beale's algorithms for solving quadratic programming problems.

UNIT III

Analytical structure of inventory problems: ABC Analysis: EOQ problem with and without shortages with (a) instantaneous production (b) finite constant rate (c) shortages permitted random models where the demand follows uniform distributing, multistage inventory subject to constraints,

UNIT IV

Queuing models-specifications and effectiveness measures. Littles formula, steady-state solutions M/M/1 and M/M/C models with associated distributions of queue-length and waiting time. M/G/1 queue. Steady-state solutions of M/Ek/1.Transient solution of M/M/1 queue.

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CLO-PLO Mapping Matrix for MSTSDAO325						
		PLO				**Average CLO**
CLO		PLO1	PLO2	PLO3	PLO4	
	CLO1	2	3	2	2	**2.25**
	CLO2	3	3	2	3	**2.75**
	CLO3	3	2	3	3	**2.75**
	CLO4	2	3	3	3	**2.75**
	Average PLO	**3**	**2.75**	**2.5**	**2.75**	**2.625**

Recommended Text Books & References:

- Taha H.A. (1982) Operational Research: An introduction;
- Macmillan. Hadley G.(1964) Nonlinear and Dynamic Programming; Addision Wesley.
- Bazara and Shetty (1979) Nonlinear Programming Theory And Algorithms; John Wiley
- KantiSwarup, P.K. and Singh,M.M.. (1985) Operation Research; Sultan Chand & Sons.
- Rios's (1989): Optimization Theory and Applications, Wiley Eastern
- Hadley G. and Whitin T.M. (1963) Analysis of Inventory Systems; Prentice Hall.
- Hillier F.S. and Lieberman G.J. (1962) Introduction to Operation Research; Holden Day.Murthy K.G (1976) Linear and Combinatorial Programming; John Wiley.
- Kleinrock L. (1975) Queuing Systems Theory Vol.1, John Wiley.

Syllabus for Two-year Master's Programme in Statistics
3rd- Semester for the year 2025 onwards under NEP 2020
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Course Title: Information Theory

Course Code: MSTSDIT325 **Total number of Credits: 04**

Total Contact Hours:60 hrs. **Max. Marks:100**

Course Learning Objectives:

- To introduce the elementary and advanced concepts of Information theory.

Course Learning Outcomes (CLO's)

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

CLO 1: Describe the techniques of Entropy.

CLO 2: Understand the concepts of Shannon's fundamental inequalities.

CLO 3: Understand the concepts of Markov chain.

CLO 4: Understand the Entropy under Stochastic Regimes

UNIT-I

Basic Concepts of Information Theory: Quantitative measure of information, Binary unit of information, measure of uncertainty and its properties, measure of information for two dimensional discrete and continuous finite probability schemes. Measure of mutual information. Redundancy, efficiency and channel capacity. Uniqueness of the entropy function, entropy maximization problem.

UNIT-II

Elements of Encoding: Purpose of encoding, separable binary codes, Shannon-Fannon encoding. Condition for noiseless coding. Fundamental theorem of discrete noiseless coding. Huffman's minimum redundancy code. Fundamental theorem of discrete encoding in presence of noise.

UNIT-III

Entropy under Stochastic Regimes: Finite Markov Chains. Basic theorem on regular Markov chain. Entropy of a simple Markov chain. Entropy of a discrete stationary source. Discrete channels with finite memory. Extension of discrete memoryless noisy channels.

UNIT-IV

Inequalities of Information Theory: Kullback-Leibler measure of information. Mean information for discrimination and divergence and their properties, Some important generalizations of entropy measures and inequalities and their properties.

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CLO-PLO Mapping Matrix for MSTSDIT325						
		PLO				**Average CLO**
CLO		PLO1	PLO2	PLO3	PLO4	
	CLO1	2	3	2	2	**2.25**
	CLO2	3	3	2	3	**2.75**
	CLO3	3	2	3	3	**2.75**
	CLO4	2	3	3	3	**2.75**
	Average PLO	**3**	**2.75**	**2.5**	**2.75**	**2.625**

Recommended Text Books & References:

- Reza,F.M(2012).: An Introduction to Information Theory, McGraw Hill
- Mathai, A.M. and Rathie,P. N.: Basic Concepts in Information Theory and Statistics, Wiley Eastern.
- Ash, R.: Information Theory, Wiley Eastern.
- Kullback, S.: Information Theory and Statistics, Dover Publication.
- Yeung,R.W:A,First course of information theory(2004),Kluwer Academics.

Syllabus for Two-year Master's Programme in Statistics
3rd- Semester for the year 2025 onwards under NEP 2020
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Course Title: Bio-Statistics

Course Code: MSTSDBS325 **Total number of Credits: 04**

Total Contact Hours:60 hrs. **Max. Marks:100**

Course Objectives: To introduce the advanced concepts of Bio-Statistics.

Course Learning Outcomes:

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

CLO 1: the concepts of cohort studies

CLO 2: the measures of association.

CLO 3: the concepts of Diagnostic tests.

CLO 4: the application of Bayes' Theorem in Medical Science.

UNIT-I

Epidemiological method: Evolution of epidemiology, causal relationship, establishing a causal relationship, prevalence, incidence, prevalence versus incidence. Types of study design: - Cross-sectional study

UNIT- II

Case-Control study: Measures of association in case control studies, cohort studies; measures of association: Odd's and relative risk, Chi-square test. Fisher's exact test and correlation in epidemiological data. Experimental study designs, ecological study, importance of sample size in research design.

UNIT- III

Field and Clinical Trails, Diagnostic tests: Accuracy of a diagnostic test, true positive, true negative, false positive, false negative, confusion matrix (2×2 contingency table), calculating overall accuracy, sensitivity and specificity; predictive values, Importance and limitations of accuracy as a single metric.

UNIT- IV

Bayes theorem, Likelihood ratio. LR of positive tests (LR+) & LR of a negative test (LR-). Post test odds when the test outcome is positive (negative). Tree method for obtaining post -test probabilities, Receiver operating characteristics curve.

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CLO-PLO Mapping Matrix for MSTSDBS325						
		PLO				**Average CLO**
CLO		PLO1	PLO2	PLO3	PLO4	
	CLO1	3	3	3	2	**2.75**
	CLO2	3	2	2	3	**2.5**
	CLO3	3	2	3	3	**2.75**
	CLO4	2	3	3	3	**2.75**
	Average PLO	**2.75**	**2.25**	**2.75**	**2.75**	**2.5**

Recommended Text Books & References:

- Medical Statistics, Principles & Methods, K.R. Sundaram, S.N. Dewidi & Sreenivas, BI publications, pvt. Ltd. New Delhi.
- Daniel, W. W., & Cross, C. L. (2018). Biostatistics: A foundation for analysis in the health sciences (11th ed.). Wiley.

Syllabus for Two-year Master's Programme in Statistics
3rd- Semester for the year 2025 onwards under NEP 2020
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Course Title: Bayesian Inference

Course Code: MSTSDBI325 **Total number of Credits: 04**

Total Contact Hours:60 hrs. **Max. Marks:100**

Course learning Objectives:

- To provide the understanding of the fundamentals of Bayesian inference including concept of subjectivity and priors by examining some simple Bayesian models and linear regression in a Bayesian framework.

Course Learning Outcomes (CLO's)

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

CLO 1: ascertain the concepts of the Bayesian approach.

CLO 2: use different types of priors, and they will have the ability to do basic data analysis.

CLO 3: calculate posterior probabilities using Bayes' theorem.

CLO 4: apply the Bayesian inference to real life scenario.

UNIT-I

Fundamentals of Bayesian Statistics: Conditional probability and its applications in Bayesian analysis, Bayes theorem for events, Bayes factor, Generalized Bayes theorem for events, Bayes theorem for future events, Bayes theorem for random variables and Sequential nature of Bayes theorem.

UNIT-II

Prior distribution and types of prior distributions, proper prior, improper prior, conjugate prior, Jeffrey's prior, informative and non-informative priors.
Bayesian method of estimation: Bayes estimation of Binomial, Poisson, exponential, and Weibull distributions by using various types of priors.

UNIT III

The normal model, Normal data with a non-informative conjugate and semi conjugate prior distributions. Inference for the mean, conditional on the variance, Joint inference for the mean and variance.

UNIT IV

Large sample approximations: Approximations based on posterior modes, methods of maximizing functions, conditional maximization, Newton-Raphson method of maximization, approximation of posterior densities using normal, Tierney & Kadane and Laplace's approximation.

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CLO-PLO Mapping Matrix for MSTSDBI325						
		PLO				Average CLO
CLO		PLO1	PLO2	PLO3	PLO4	
	CLO1	3	3	3	2	**2.75**
	CLO2	3	2	2	3	**2.5**
	CLO3	3	2	3	3	**2.75**
	CLO4	2	3	3	3	**2.75**
	Average PLO	**2.75**	**2.25**	**2.75**	**2.75**	**2.6875**

Recommended Text Books & References:

- Jim Albert (2009):Bayesian Computation with R , Springer.
- Peter M Lee (2012): Bayesian Statistics: An Introduction, 4th Edition, Wiley.
- Andrew Gelman, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari and Donald B. Rubin (2014): Bayesian Data Analysis, CRC Press.
- Thomas J. Faulkenberry(2025): Bayesian Statistics: The Basics 1st Edition, Routledge.