

**DEPARTMENT OF STATISTICS AND OPERATIONS RESEARCH  
FACULTY OF SCIENCE  
A.M.U., ALIGARH**

**Syllabus for Ph.D admission test 2020-21**

**STATISTICS**

**SECTION-B**

Theory of simplex methods, simplex algorithm, degeneracy, duality in linear programming.

Random variables (*rv*) and function for *rv*, probability density function (*pdf*), cumulative distribution function (*cdf*). Joint, marginal and conditional distribution. Compound, truncated and mixture distributions. Mathematical expectation and conditional expectation.

Discrete and continuous distribution and their properties, probability generating function (*pgf*), moment generating function (*mgf*) and characteristic function (*cf*). Properties of *cf* and inversion theorem. Central and non-central  $\chi^2$ , *t* and *F* distributions. Multinomial, bivariate and multivariate normal distributions.

Distribution of functions of random variables. Inequalities in probability and various mode of convergence and their inter-relationships. Weak and strong law of large numbers. Central limit theorem.

Order statistics, distribution of single and joint order statistics and of censored sample.

Non-parametric tests: Sign test, signed rank test, Kolmogorov-Smirnov test, run test, Wilcoxon Mann-Whitney test, Median test, Ansari-Bradley test, Mood test, Kendall's tau test, test of randomness, consistency of test and ARE.

BLUE estimators, Gauss-Markov theorem, Test of linear hypothesis-one and two way classifications. Fixed, random and mixed effect models. Variance components. Bivariate, multiple and polynomial regressions and use of orthogonal polynomials, Residuals and their plots as test for departure from assumptions of fitness of model, homogeneity of variance and detection of outliers, multicollinearity.

Estimation of population mean, total and proportion in SRS and Stratified sampling, Estimation of gain due to stratification, Ratio and Regression methods of estimation, Optimality of Ratio estimate, cluster sampling : Estimation of population mean and their variances based on cluster of equal sizes, Variance in terms of intra-class correlation coefficient, Two stage sampling : Estimation of Population total and mean with equal first stage units, Variances and their estimation, Optimum sampling and sub-sampling fractions, Double sampling for Ratio and Regression methods of estimation, Double sampling for stratification.

Criteria of a good estimator. Sufficiency and completeness.

Rao-Blackwell and Lehmann-Scheffe theorems. Cramer Rao lower bound approach to obtain MVUE and efficient estimators.

Maximum likelihood estimators (mle), its small and large sample properties. Most powerful (MP), uniformly most powerful (UMP) and Uniformly most powerful unbiased (UMPU) test. UMP tests for monotone likelihood ratio (MLR) family of distributions. Likelihood ratio test (LRT) and its asymptotic distribution, Construction of similar and UMPU tests through Neyman structure. Interval estimation. Uniformly most accurate one sided interval and its relation to UMP test of one sided null against one sided alternative hypothesis.

Bayes and minimax estimator.

Singular and non-singular multivariate normal distribution, Wishart distribution, Generalized variance. Distribution of quadratic forms. Estimation of simple, partial and multiple correlations and their null distribution.

Hotelling  $-T^2$  and Mahalanobis-  $D^2$ , Principal component and canonical correlations.

Analysis of variance and covariance of CRD and RBD, Missing plot techniques,  $2^n$  and  $3^2$  factorial designs, complete and partial confounding, Fractional replication in  $2^n$  systems.

BIBD, simple lattice design, split-plot design and strip-plot design.

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**OPERATIONS RESEARCH**

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Dual and Revised Simplex Methods, Sensitivity Analysis in Linear Programming, Linear Programming under uncertainty.

Unconstrained Optimization: Fibonacci, Golden section and Quadratic interpolation methods, The general Nonlinear Programming Problem, Difficulties introduced by nonlinearity, The Kuhn-Tucker necessary conditions for optimality, Solution of simple NLPP using K-T conditions, Quadratic Programming : Beale's method, Restricted basis entry method (Wolfe's method), Convex Programming : Methods of feasible directions, Rosen's gradient projection method for linear constraints.

Marketing Management: Meaning and definitions of marketing and marketing management, Importance of marketing management in Indian economy, Functions of marketing, Objective & functions of advertising models, Media selection models, Warehouse location, Financial management, Capital structure decisions.

Basic concept of network analysis, The maximal flow problem, Max flow min cut theorem, the shortest route problem, shortest route algorithm, Bellman's principle of Optimality, Solution of stage coach problem by Dynamic Programming, The general characteristics of Dynamic Programming Problems, Solution of LP problems by DP.

Applications of Integer Programming: Capital budgeting problem, the Knapsack problem, Travelling salesman problem, The fixed charge problem, The cutting stock problem and the set covering problem, Cutting Plane Methods, Gomory's  $f$ -cut, Branch and Bound method: Branching, bounding and fathoming, Land and Doig's method, Dakin's approach.

Determination of critical path, CPM, PERT, Probability of completing the project on schedule.

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