DEPARTMENT OF STATISTICS
KAKATIYA UNIVERSITY, WARANGAL - (T.S)
Ph.D. Entrance Examination in Statistics-2022
SYLLABUS

1. **Mathematical Analysis:** Uniform convergence of Sequences and Series of functions Cauchy criterion for uniform convergence, Mn test and Weierstrass M test., Improper integrals of first and second kind, Statement of comparison test for convergence, definition and convergence of Beta and Gamma functions.Functions of Several Variables, Concept of Partial derivatives, maximum and minimum values of functions of two variables, methods of Lagrange multipliers.Functions of Complex Variables : Concept of continuity and derivative of complex function - Analytic function - Cauchy-Riemann equations - Statements of Cauchy Theorem, Cauchy integral formula, Statements of Taylor's and Laurent's series - Singular points - Poles - Residues.

2. **Matrix theory** : Quadratic forms in real field - rank and index - Classification of real quadratic forms - necessary and sufficient condition for a definite form. Characteristic roots and Characteristics vectors of a matrix - nature of Characteristics roots of Hermitian and Orthogonal matrices,. Generalized Inverse of a Matrix : Definition of generalized inverse and its applications to solution of linear equation - the Moore Penrose inverse - Least squares solutions of in consistent linear equations.

3. **Probability Theory:** Random variables: distribution function and its properties. Joint distribution of two random variables, marginal, conditional distributions. Expectation of random variable, Moments and Moment generating function. Expectations of functions of random variables, Conditional expectation, conditional variance-examples. Characteristic function and its properties. Inversion and uniqueness theorems with examples (Functions which cannot be characteristic functions). Levy continuity theorem. Inequalities: Tchebychevs, Markov, Cauchy-Schwartz, Jensons, Liapunovs, Holders, Minkowskys inequalities. Convergence of a sequence of random variables: Convergence in law, in probability, almost sure convergence, and convergence in r-th mean and their interrelationships. Borel - Cantelli lemma, Borel 0-1 law. Law of large numbers: Weak law of large numbers, Bernoulli and Khintchins WLLN, Kolmogorov s inequality, Borel SLLN, Kolmogorov SLLN for independent r.v.'s and for iid r.v's, examples. Central Limit theorem: Demovire-Laplace CLT, Lindberg-Levy CLT, Liapunov's CLT, statement of Lindberg - Feller form of CLT with examples.

4. **Distribution Theory:**, Theoretical distributions Normal, lognormal, exponential, Cauchy, Weibull and Cauchy distributions- properties and applications. Bivariate normal, multivariate normal and multinomial distributions with their properties and applications. Functions of random variables and their distributions using Jacobean of transformations, Distribution of Central Chi - squares, t and F distributions with their properties and applications. Non-Central Chi-squares, t and F distributions and their properties (Statements only).Distribution of $\bar{X}$ and s^2 for samples from normal population. Distribution of Order statistics and Range. Joint and marginal distribution of order statistics. Distribution of sample quantiles.

5. **Estimation Theory:** Unbiasedness, sufficiency, consistency and efficiency of a point estimate with examples. Neyman's factorization theorem, UMVU estimation, Cramer-Rao inequality, Rao-Blackwell theorem, Fisher's information, Bhattacharya bounds, completeness and Lehman - Scheffe

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theorem. Median and Modal unbiased estimation, Method of moments and maximum likelihood estimation. Examples of MLE, consistency and asymptotic normality of the consistent solutions of likelihood equations. Definition of CAN and BAN estimators and their properties-examples. Concept of U statistics and examples. Interval estimation- method of pivot and shortest length confidence interval. Confidence interval for the parameters of Normal, Exponential, Binomial and Poisson distributions. Confidence interval (CI) for quantiles, Tolerence limits and examples.

6. **Testing of Hypotheses:** Concepts of tests of statistical hypothesis, types of error, level of significance, power, critical region and test function. Concepts of MP and UMP tests. Neyman-Pearson lemma and its applications, one parameter exponential family of distributions. Concepts of unbiased and consistent tests. Likelihood ratio (LR) criterion with simple applications (including homogeneity of variances). Statements of asymptotic properties of LR tests. Large sample tests of population means, proportions and correlation coefficients. Relation between confidence intervals, and hypothesis testing. Wald's SPRT for testing a simple null hypothesis against simple alternative hypothesis and its OC and ASN functions. SPRT procedure for binomial, Poisson, normal and exponential distributions. Concepts of loss, risk and decision functions, admissible and optimal decision functions, estimation and testing viewed as decision problems, a priori, a posteriori distributions, conjugate families, Baye's and minimax decision functions with applications to estimation with quadratic loss.

7. **Non - Parametric Tests :** Non - parametric tests for (i) one sample case: Sign test, Wilcoxon signed rank test for symmetry, runs test for randomness, Kolmogorov -Smirnov (K-S) test for goodness of fit, chi-square test for goodness of fit and independence in contingency tables, (ii) two sample case: Sign and Wilcoxon tests for paired comparisons. Wilcoxon - Mann Whitney test and K-S test and tests for independence based on spearman's rank correlation and Kendalls Tau, Kruskal-Wallis test and Friedman's test.

8. **Multivariate Tests:** Principal Component Analysis, Factor analysis, Canonical Correlation, Cluster analysis. Multivariate tests based on Hotelling's T2 and Mahalanobis D2 statistics for one sample problem, two sample problem and classificatory problems between two normal populations based on Fisher's discriminant function.

9. **Statistical Process and Quality Control:** Construction of control charts for attribute and variable data, O.C, ARL of control charts. Moving average and exponentially weighted moving average charts, Cu-sum charts using V-masks. Acceptance sampling plans for single, double and sequential sampling plans and their properties. AOQ, AOQL. Designing RSP for specified AOQL and LTPD. Process Capability analysis, capability indices Cp, Cpk,and Cpm.

10. **Sampling Techniques :** Estimation of population mean, population total and variance of the estimator in the following sampling methods.: Cluster sampling with clusters of equal and unequal cluster sizes. Two stage sampling with equal and unequal first stage units. Ratio and Regression estimators in Simple Random Sampling and Stratified Random Sampling. Unequal probability sampling-PPSWR/WOR methods-Hansen-Horwitz estimator, Horvitz -Thompson estimator and Yates and Grundy variance estimators, Non - sampling errors- Sources and treatment.

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11. **Linear Models and Regression Analysis:** Gauss - Markov linear model, BLUE for linear functions of parameters,Gauss-Markov theorem, Aitken's generalized least squares. Concept of multicollinearity. Analysis of multiple regression models-Estimation and testing of regression parameters, tests of sub - hypothesis. Derivation of multiple and partial correlations coefficients and testing for the same. Robust, Ridge regression procedures.

12. **Design and Analysis of Experiments:** Analysis of variance two - way classification model with more than one (equal) observations per cell with interaction. Fisher's least significance difference (LSD) method and DMRT. Analysis of covariance one-way and two - way classifications. Analysis of 2^k (k =2, 3, 4) and 3^2 factorial experiments. Total and partial confounding of 2^2, 2^3, 2^4 and 3^2 factorial designs. Concept of balanced partial confounding. Split plot design and its analysis. Balanced incomplete block design (BIBD) - parametric relations, Intra - block analysis and recovery of inter block information. Partially balanced incomplete block design with two associate classes (PBIBD (2)) - parametric relations and intra -block analysis. Youden Square design and Simple Lattice Design with analysis. Concept of Response Surface Methodology (RSM), the method of Steepest Ascent. Response Surface Designs-designs for fitting first order and Second order models. Variance of estimated response. Second order Rotatable Designs (SORD), central composite designs (CCD)-role of CCD as alternative to 3^k designs, rotatability of CCD.

13. **Reliability Theory :** Reliability concepts, Systems of components, Series and parallel systems, Coherent structures and their representations in terms of paths and cuts, Modular decomposition. Reliability of coherent systems, Reliability of independent components, Association of random variables.Bounds on system reliability and improved bounds on system reliability under modular decomposition. Life distribution, aging, IFR, DFR, DFRA, NBU and NBUE classes, Exponential distribution and itd no aging property, Reliability estimation in two-parameter Gamma, Weibull and Log-normal distributions.

14. **Optimization Techniques :** LPP, Various types of solutions to an LPP,Duality in LPP,Transportation and Assignment problems and their solutions, Game theory. Integer Programming Problem, Queuing and Inventory problems. Basic concepts of Networks constraints; Construction of Network and critical path; PERT and CPM.

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