DEPARTMENT OF APPLIED STATISTICS

1. 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. Characteristics 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 t-th mean and their interrelationships. Slutkys theorem and its application.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 iidr.v's, examples. Central Limit theorem: Demovire-Laplace, CLT, Lindberg-Levy CLT, Liapunov's CLT, statement of Lindberg–Feller form of CLT with examples. Asymptotic distribution of sample quantiles.

2. Distribution Theory:

Theoretical distributions Normal, logormal, exponential, Laplace Cauchy, weibull and Pareto 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 X and s2 for samples from normal population. Distribution of Order statistics and Range. Joint and marginal distribution of order statistics. Distribution of sample quantiles.

3. Estimation Theory:

Unbiased ness, sufficiency, consistency and efficiency of a point estimate with examples. Neyman's factorization theorem, UMVU estimation, Crammer–Rao inequality, Rao–Blackwell theorem, Fishers information, Bhattacharya bounds, completeness and Lehman–Scheffe theorem. Median and Modal unbiadsed estimation, Estimation of bias and standard deviation of point estimation by Jacknife and Bootstrap methods with examples. Method of moment 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.

4. Testing of Hypotheses:

Concepts of tests of statistical hypothesis, types of error, level of significances, 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.

5. 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 Kendaulls Tau, Kruskal-Wallis test and Friedman's test.

6. 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.

7. 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.

8. 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 , Bootstrap , Non Linear , Logistic , Probit Methods of Regression. Fixed, Random and Mixed effects Models. Estimation of variance Components.

9. 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 2k (k = 2, 3, 4) and 32 factorial experiments. Total and partial confounding of 22, 23, 24 and 32 factorial designs. Concept of balanced partial confounding. Fractional factorial designs- One half and one quarter fractions of 2k design. 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 3k designs, rotatability of CCD.

10. Optimization Techniques :
Duality in LPP, Integer Programming Problem, Sensitivity Analysis, parametric programming, Introduction to Simulation: Generation of random numbers from Uniform, Normal, Exponential, Cauchy and Poisson distributions, Estimating the reliability of the random numbers. Simulation to Queuing and Inventory problems. Basic concepts of Networks constraints; Construction of Network and critical path; PERT and CPM; Network flow problems. Time Cost Analysis.