Statistics

Include Research methodology syllabus from mathematics

1.Mathematical Methods :

Countability, supremum and infimum of sets of real numbers. Limit point of a set – open sets, closed sets etc. (developed through general metric space and Rn being considered as a special case), compactness. Continuous functions, uniform continuity, absolute continuity. Sequences and series of real numbers, limit superior, limit inferior and limit of a sequence. Cauchy sequences, convergence of series, tests for convergence of series, absolute convergence, Cauchy products.

Algebra of Matrices, Linear Systems of Equations, Eigen Values and Quadratic Forms.

2.Sample Surveys :
Objectives of sample survey, planning for sample survey. Basic issue related to estimation [biased and unbiased estimator, mean square error (MSE)] and confidence interval, Concept of sampling distribution of statistic, Sampling and non-sampling errors.
Simple random sampling with and without replacement, Systematic sampling and related results on estimation of population total, mean and proportion, Stratified sampling, Formation of strata and number of strata, Allocation problems and estimation problems.

Inclusion probabilities, Horwitz-Thompson estimator and its properties, PPSWR, PPSWOR methods (including Lahiri's scheme) and related estimators of a finite population mean, Midzuno sampling design, πps design, Ratio and Regression estimators based on SRSWOR method of sampling, Their properties and MSEs, Cluster sampling, Estimator of population mean and its properties, Two-stage sampling with equal number of second stage units, Double sampling and its uses in ratio and regression estimation.

3.Probability Distributions :
M.g.f., p.g.f., c.g.f., characteristic function of random variables, Moments: raw moments, Central moments, Factorial moments, Joint p.m.f. of discrete random variables, Joint p.d.f. of continuous random variables, Marginal and conditional density using joint density, Conditional expectation and variance, Independence of random variables, Bivariate exponential distribution: joint p.d.f., Marginal p.d.f.s, properties, Multivariate normal distribution: joint p.d.f., Marginal p.d.f.,

Conditional p.d.f., Joint m.g.f., Multinomial distribution: joint p.m.f., Marginal p.m.f., Conditional p.m.f., Joint m.g.f., Function of random variables, Joint density of functions of random variables using Jacobian of transformation, Convolution of random variables.

Linear and multiple regression, Regression Function, Best linear regression function, Multiple and Partial Correlation, Sampling distribution of statistics from univariate normal random sample, Non-central Chi-square, t and F-distributions and their properties, Distribution of linear and quadratic forms in i.i.d. Standard normal variables (Technique based on m.g.f.), Independence of two linear forms, Independence of two quadratic forms and independence of linear form and quadratic form, Fisher Cochran's theorem, Distribution of rth order statistics, Joint distribution

of several order statistics and their functions, Distribution of function of order statistics, Extreme values and their asymptotic distributions with applications.

4.Probability Theory :
Algebra of sets, fields and Sigma-fields (-fields), Minimal fields, Minimal -field, limit of sequences of subsets, sigma-field generated by a class of subsets, Borel fields. Probability measure on a sigma-field, probability space, continuity of a probability measure, real and vector-valued random variables (r. v. s), distribution functions (d. f.), discrete r. v. s, r. v. s of the continuous type, decomposition of a d. f. Expectation of a real r. v. Linear properties of expectations. Characteristic functions and their simple properties. Convergence of a sequence of r. v. s., convergence in distribution, convergence in probability, almost sure convergence and convergence in quadratic mean and their interrelations. Monotone convergence theorem and dominated convergence theorem.
Independence of two events and n (> 2) events, sequence of independent events, independent classes of events, independence of r. v.s, Borel zero-one law, Khintchin's weak law of large numbers, Kolmogorov strong law of large numbers, continuity theorem for characteristic functions, Lindeberg's CLT.

5.Stochastic Processes :
Markov chains with stationary transition probabilities, properties of transition functions, classification of states, Stationary distribution of a Markov chain, existence and uniqueness, convergence to the stationary distribution. Methods based on Markov chains for simulation of random vectors. MCMC algorithm. Gambler’s ruin problem, Transient states. Estimation of transition probabilities. Numerical Illustrations and calculations of transition probabilities. Branching processes. Introduction to Wiener Process and Brownian Motion. Poisson process, Birth and Death processes. Finite state continuous time Markov chains. Simple queuing systems, Stationary solution for using birth and death process approach. Estimation of transition probabilities, estimation of functions of transition probabilities in Markov chains.

6.Multivariate Analysis :

Singular and nonsingular Multivariate normal distribution, pdf and mgf, singular and nonsingular normal distributions, distribution of a linear form and a quadratic form of normal variables, marginal and conditional distributions. Multiple regression and multiple and partial correlation coefficients, Definition and relationships. MLE's of the parameters of multivariate normal distribution and their sampling distributions Wishart distribution, Properties of the Wishart Distribution. Tests of hypothesis about the mean vector of a multinormal population, Hotelling's -statistic; Rao's U-statistic and their distribution, Applications of Hotelling's -statistic.

Introduction to Principle Components, Canonical correlation coefficients, Cluster Analysis. Classification problem, Discriminant analysis, Mahalanobis -statistic. MANOVA for one way and two ways classified data, Wilk's criteria.

7.Statistical Inference :
Sufficiency, completeness, uniformly minimum variance unbiased estimators, C-R inequalities, exponential class of densities and its properties, some special classes of distributions admitting complete sufficient statistics, extensions of these results to multi-parameter situation. Test function, Neyman-Pearson lemma for test functions. Uniformly most powerful tests for one sided alternative for one parameter exponential class of densities and extension to the distributions having monotone likelihood ratio property. Confidence Intervals, shortest expected length confidence intervals, relations with testing of hypotheses, uniformly most accurate confidence intervals.

Consistency and asymptotic normality (CAN) of real and vector parameters, Invariance of consistency under continuous transformation. Invariance of CAN estimators under differentiable transformations, generation of CAN estimators using central limit theorem. Non Parametric Tests.

8.Linear Models and Design of Experiments :

Gauss-Markov set up, Least square estimation, Estimability of linear parametric function, necessary and sufficient condition for estimability, Best Linear Unbiased Estimator (BLUE), Gauss-Markov theorem, Variances and covariances of BLUE's. Estimation space, Error space, their ranks, Simultaneous estimates of linear parametric function, Estimation of error variance, Estimation with correlated observations, Least square estimates with restriction on parameters, Method of generalized least squares, Distribution of error sum of squares and Regression sum of squares, distribution of BLUE's, their independence (Under the normality assumption), Distribution of conditional error sum of squares, Distribution of sum of squares due to null hypothesis, Test of hypothesis for one or more than one estimable linear parametric function, Test of hypothesis of equality of all estimable functions to zero, Testing of sub hypothesis for full rank model, Power of F-test, Simultaneous confidence interval for n linearly independent estimable parametric functions, One way and two way classified data.

One way classification models, random effect model for one way classification,

Two way classification model with equal number of observations per cell with and without interactions, General two way block designs, various characteristics of general two way block design: connectedness, balancedness and orthogonality, Balanced Incomplete Block Design (BIBD). 2k full factorial designs, analysis of single as well as more than one replicates using ANOVA, technique of confounding, total and partial confounding in 2k full factorial designs.