Syllabus for Ph.D. Entrance-Test 2025

UNIT- 01: PROBABILITY AND DISTRIBUTION THEORY

Standard Univariate discrete distributions: Discrete Binomial, Poisson, Negative Binomial, Geometric, Hyper geometric, Logarithmic series distribution, Power series and generalized power series distributions and their structural properties and applications. Univariate Continuous distributions: Uniform, Beta, Gamma, Exponential, Pareto, Weibull, Laplace, Normal, Cauchy, Logistic and Lognormal distributions and their structural properties and applications. Modes of convergence, weak and strong laws of large numbers, central limit theorem (i i d case) Order Statistics: Distribution and properties. Joint and marginal distributions of order statistics. Distribution of median and range. Sampling distributions. Chi-square, t and F distributions and their properties and applications, non-central t, F and Chi-square distribution. Test of significance of Normal, t, F and Chi-square.

UNIT- 02: SAMPLING THEORY

Basic ideas and distinctive features of sampling: Review of important terminology used in sampling. Concept of Bias, mean square error, Relative efficiency. Simple random sampling with and without replacement. Estimators of population proportion. Determination of sample size. SRS as applied to qualitative characteristic.

Stratified random Sampling: Estimation of the population mean/total and its variance, choice of sample sizes in different strata, variance under different allocations. Comparison with unstratified sampling. Estimation of the gain in precision due to stratification, construction of strata.

UNIT - 03: SAMPLING DISTRIBUTIONS

Sampling distributions: F distribution and its properties and applications. Test of significance of F. Relation of F distribution with the other distributions. Examples based on F distribution. Non central F-distribution and related examples. Z-distribution & Z-test and its properties and applications. t distribution and its properties and applications. Test of significance of Z and t. Relation of Z& t distribution with the other distributions. Examples based on t distribution and Z test. Non-central t-distribution and related examples.

Convergence: Convergence of a sequence of random variables, convergence in probability, almost sure, Convergence of a sequence of pair of random variables. Convergence of moments. Weak law of large numbers (WLLNs): Condition for the WLLNs. Strong law of large number (SLLN) and examples.

UNIT- 04 : STATISTICAL INFERENCE

Statistical Inference: Problems of estimation. Criteria of unbiasedness, consistency and efficiency. Chapman Robin's Inequality, Cramer-Rao Inequality. Minimum variance unbiased (MVU) estimation, UMVU Estimation, Asymptotic relative efficiency, Invariance of consistent estimator under continuous transformation.

Sufficient and Complete Statistics: Sufficiency, Minimal sufficient statistic, Factorization theorem, Fisher–Neyman criterion. Characterization of distributions. Admitting Sufficient Statistics. Exponential families and Pitman families, Invariance property of sufficiency under one-to-one transformation of sample space. Fisher information for one and several parameter models. Rao-Blackwell theorem. Completeness and Lehman – Scheffle theorem.

UNIT- 05: LINEAR MODELS

Linear models; Gauss Markov set up, Model classification, Normal equations and least squares estimate, Error and estimation space, Variance and covariance of least square estimates, Estimation of error variance, estimation with correlated observations, least square estimates with restriction on parameters.

Test of hypotheses for one and more than one linear parametric functions, Tests of linear hypotheses, estimable linear hypotheses, confidence intervals and prediction intervals, Generalized F test, generalized t test.

UNIT-06 : DEMOGRAPHY

Vital Statistics, coverage and content errors in demographic data, use of balancing equations, Chandrasekharan-Deming formula to check completeness of registration data. Dependency ratio. Accuracy of age data on sex and age: Whipple's and Myer's indices.

Measure of fertility and mortality: Mathematical models on fertility and human reproduction process, Dandekar's modified binomial and Poisson models. Distributions of time to first birth, William Brass Model, Singh's model and Singh's modified model, inter-live birth intervals and of number of births. Mortality: concepts and rates; measures of infant mortality rate. Force of mortality. Life table and its construction: Complete and abridged. Relationship between life table functions and their estimation. Relationship between abridged life table functions.

UNIT- 07: DESIGN AND ANALYSIS OF EXPERIMENTS

Design of experiments: Introduction to basic designs and their analysis, Balance Incomplete Block Design. Intra block analysis, Inter block analysis, recovery of inter block information; General factorial experiments, factorial effects; best estimates and testing the significance of factorial effects; study of 2 and 3 factorial experiments in randomized blocks; complete and partial confounding.

UNIT-08: MULTIVARIATE ANALYSIS

Multivariate Normal Distribution Theory: Marginal and conditional distribution, Joint distribution, Linear function of correlated normal variate. Characteristics function of multivariate normal distribution, Maximum likelihood estimation of the mean vector and co variance matrix and their independence. Distribution of sample mean vector. Large sample behaviour of mean vector and co-variance matrix. Distribution of non-central chi-square.

Quadratic form and its distribution. Multiple and partial correlation co-efficient and their sampling distribution. Simple regression model, regression co-efficient and distribution of sample regression co-efficient. Test of linear hypothesis about regression co-efficient and interval estimation.

UNIT-09 : OPERATIONS RESEARCH

Definition and scope of Operational research, Necessity of Operations Research in Industry; phases in Operations Research. Formulation of Linear programming problems (LPP), Canonical and standard form of LPP, Basic definitions of LPP. Methods of solving LPP: Graphical method, Simplex method, Big-M method, Two-phase method and Extreme point theorems; Revised Simplex Method. Duality in Linear programming problem, Symmetric and asymmetric dual problems, Unrestricted variables in dual LPP. Relationship between Primal and Dual LPP. Duality theorems.

UNIT-10 : INDUSTRIAL STATISTICS & RELIABILITY THEORY

Consumer and producer's risk, Operating Characteristic curve/function (OC). Corrective Sampling Plan, Average Sample Number, Average out-going Quality, Graphical, Average out-going Quality Limit, Single Sampling Plan, Double Sampling Inspection Plan and sequential sampling plan.

Reliability concepts, hazard rate, distribution of longevity and moments. Some important theorems based on reliability theory. Common life time distributions: exponential, Weibull, gamma, Gumbel and normal distributions. Type I and Type II censored samples. Reliability and hazard rate of a system with independent units connected in (a) series and (b) Parallel systems.