Syllabus for Ph. D. Entrance Test for Session 2024-25
Section-A

(Research Methodology)

Meaning of Research, Types of research, Research Problem and its characteristics, Hypothesis and its Types, Methods of Research Studies and Review of Literature

Data Collection: Collection Tools, Presentation Techniques, Measurement Scales.

Concept of Central Tendency and Dispersion and their measures. Correlation and Regression Analysis for bivariate and multivariate data.

Probability Theory: Basic concepts of probability, Definition of probability , Addition , Multiplication and Conditional probability theorems, Bayes theorem, Random variable : Marginal and conditional distributions associated with a two dimensional distributions . Expectations, p. g. f. , m. g. f.; Standard discrete and continuous distributions. Sampling distributions of Chi Square, F & t .

Analysis of categorical data: Contingency of categorical data ,Independence & Association of attributes, Various measures of association for two way classified data.

Index Numbers : Construction and uses of index numbers; Index numbers of prices, Cost of Living index number, Base shifting and splicing of index numbers.

Time Series Analysis: Measurement of Trend, Seasonal fluctuations; Cyclical movement and Random fluctuations.

Statistical Quality Control : Control charts for variables (mean and range, mean and standard deviation). Control chart for fraction defective, Control chart for the number of defects per unit, Use of 3σ control limits, Natural tolerance limits and specification limits; Modified control limits. Sampling Inspection Plan : Concepts of Acceptance quality level (AQL), Lot tolerance proportion defective (LTPD) and indifference quality.

Research Report : Format of the research report, Style of writing the report, References and bibliography, Research Ethics.

(1) Probability Theory

Distribution functions, Moment inequalities, Probability inequalities, Mode of Convergence, Law of Large Numbers, Characteristics Function, Central Limit Theorem, Large Sample Tests.

(2) Sampling Theory

Concept of Random Sampling, Simple Random Sampling for quantitative and qualitative characters; Stratified random sampling, Ratio and regression estimate in simple random sampling, Systematic sampling, Cluster sampling. Two stage sampling. Unequal probability sampling with and without replacements.

(3) Statistical Inference (Parametric)

Problem of point estimation. Desirable properties for an estimator, Neyman -Fisher factorization theorem, Rao-Blackwell theorem, Lehman-Scheffe's theorem Cramer-Rao inequality and their applications, Bhattacharyya bounds.

Problem of interval estimation. Basic concepts of testing. Neyman- Pearson theory of testing , Construction of MP, UMP & UMPU tests Neyman structure and construction of MP similar regions.

(4) Statistical Inference (Non-parametric)

Sequential analysis, Order statistics and their sampling distributions with applications. Likelihood, Chi-square and Kolmogorov- Smirnov tests for goodness-of-fit.

One-sample location problem (Sign and Wilcoxon signed-rank tests), General two sample problem(Run test, Kolmogorov-Smirnov test, Mann-Whitney U-test and median test). Two sample location and scale problem and related tests.

(5) Design of Experiments

Linear Models, fixed, random and mixed effects models. Linear estimation theory ,BLUE , Gauss Markoff Theorem. ANOVA : one way and two way classifications under fixed effects models. Basic principles of DOE, CRD,RBD & LSD. General block designs and its C-matrix, orthogonality , connectedness, balance and resolvability. BIBD, Basic concepts of PBIBD and association schemes. Youden squares, Factorial experiments of 2^n , 3^2 and 3^3 types, Concepts of Confounding, Concept of Fractional replications in factorial experiments.

(6) Demography and Vital Statistics

Methods of obtaining demographic data, Rates and ratios, measurement of mortality. Construction of complete life tables. Concepts of Central Mortality Rates and force of mortality, Abridged life tables : Reed and Merrell's ,Greville's, Keyfitz and Frauenhal's, King's and Chiang's method . Measurement of fertility, Measurement of Population Growth : GRR and NRR. Structure of populations : Stable and quasi-stable populations, Fundamentals of stable

population theorem , intrinsic birth and death rates , Leslie's model of population growth . Population Projection : projected values & estimates, methods of projection , population size , Survival rates : UN model life table , Pearson's Type-I curve , Romaniak 's model and Coale's model fertility schedules.

(7) Multivariate Analysis

Multivariate normal distribution: marginal and conditional distributions , distribution of linear combinations of normally distributed variables , MLE of mean vector and dispersion matrix ; test of hypothesis for mean , Independence of sample mean and dispersion matrix .

Concept and estimation of simple , partial and multiple correlation coefficients and their sampling distribution. Tests of significance of these distributions. Hotteling's T^2 – statistic, Mahalanobis D^2-statistic : their uses and distributions. Behrens Fisher problem.

Wishart Distribution , classification problem, Bayes and minimax regions for classification.

Cochran's theorem , Concept and distribution of Generalized variances,   Principal components in the population , Canonical correlations .

(8) Stochastic Processes

Introduction and classification of Stochastic processes, Generating function, Convolutions, Compound distribution, Partial fraction expansion of generating functions, Recurrent events, Delayed recurrent events. Random walk models and Markov chains. Notions of Markov processes in continuous time and Chapman-Kolmogorov equations. Poisson process: simple birth process, simple death processes, simple birth and death process, Polya's processes, non-homogeneous birth and death processes, Discrete branching processes, Queuing processes : Characteristics of queueing systems, Poisson arrivals and exponential service times, (M/M/1): (∞/FCFS) model and (M/M/S): (N/FCFS) model, their steady state solutions and measures of effectiveness.

(9) Reliability Theory:

Reliability : Definition , Types, Relation between Hazard rate and Reliability function. Series System, Parallel System, k-out-of-n System, Redundant System & Types of redundancy ,Coherent Structures, Representation of Coherent System in Terms of Paths and Cuts, Modular Decomposition, Lower/Upper Bounds on System Reliability. Structural and Reliability Importance of Components.