U. P. HIGHER EDUCATION SERVICES COMMISSION, PRAYAGRAJ

Syllabus

AGRICULTURAL STATISTICS

(Subject Code-97)

UNIT 1: Mathematical Methods in Statistics

Limit and continuity; Differentiation of functions, Successive differentiation, Partial differentiation. Mean value theorems, Taylor and Maclaurin's series; Integration of rational, irrational and trignometric functions.

Differential equations of first order, Linear differential equations of higher order with constant coefficients.

Simple interpolation and extrapolation; Divided differences; Numerical differentiation and integration. Group, Ring, Field and Vector spaces, Subspaces, Basis, Gram Schmidt's orthogonalization; Galois field, Fermat's theorem and primitive elements.

Linear independence and dependence of vectors, Row and column spaces; Submatrices and partitioned matrices; Determinant, rank and inverse of a matrix; Determinant and inverse of partitioned matrices; Special matrices - Unitary, Similar, Hadamard, Circulant, Helmert's, Idempotent and Orthogonal. Eigen values and eigen vectors. Spectral decomposition of matrices. Kronecker and Hadamard product of matrices, Kronecker sum of matrices,

Permutation matrices, Full rank factorization. Grammian root of a symmetric matrix. Generalized inverses, Moore-Penrose inverse, Applications of generalized inverse; Generalized inverse of partitioned matrices; Solutions of linear equations, Equations having many solutions; Spectral decomposition of matrices; Differentiation and integration of matrices; Quadratic forms.

UNIT 2: Probability and Mathematical Statistics

Elements of measure theory, Borel field, Probability measure; Random variable, Axiomatic approach to probability; Laws of addition and multiplication; Bayes' theorem.

Discrete and continuous variables; Functions of random variables; Distribution function and its properties. Univariate and bivariate probability distributions; Conditional and marginal distributions; Independence of random variables; Transformation of random variables. Chebyshev's inequality; Bernoulli weak law of large numbers; Kolmogorov strong law of large numbers; Central limit theorem; Demoviere-Laplace central limit theorem.

Bernoulli, Binomial, Poisson, Negative binomial, Geometric, Hypergeometric and Uniform distributions. Rectangular, Normal, Exponential, Gamma, Beta, Cauchy and Lognormal distributions. Bivariate normal distribution. Probability distributions of functions of random variables. Family of Pearson distributions.

Mathematical expectation; Mathematical expectation of functions of random variables; Moment generating function, Characteristic function; Raw and central moments. Mean and variance of above mentioned distributions. Sampling distributions; Distribution of mean, difference between two means and correlation coefficient; Central t, F and chisquare distributions, their properties and interrelationships; Variance stabilizing transformations.

Order statistics; Distribution of rth order statistic; Joint distribution of several order statistics and their functions; Distribution of range and median.

UNIT 3: Statistical Inference

Point estimation: Mean square error; Unbiasedness, Consistency, Sufficiency, Completeness; Neyman factorization theorem with application; Minimum variance unbiased estimator; Cramer Rao inequality; Rao Blackwell theorem.

Methods of estimation: Method of moments, Method of minimum chisquare, Method of maximum likelihood, their properties and applications. Confidence interval estimation for parameters of Normal, Exponential, Binomial and Poisson distributions.

Testing of hypothesis- Two types of errors, level of significance and power of a test; Neyman Pearson lemma; Unbiased test; Uniformly most powerful unbiased tests and their

constructions. One and two-sample tests about mean, variance, proportion, simple correlation coefficient and simple regression coefficient; Behrens-Fisher problem; Bartlett's chi-square test; Likelihood ratio test and its asymptotic properties. Chi-square tests of goodness of fit and independence.

Non-parametric tests, Robust statistics, One and two-sample sign and Wilcoxon sign rank tests, run test for randomness, Wilcoxon-Mann-Whitney U test, Kruskal-Wallis and Friedman's tests, Kendall's coefficient of concordance.

Elements of sequential analysis; Wald's sequential probability ratio test.

UNIT 4: Applied Multivariate Analysis

Concept of random vector, Expectation operator, Dispersion matrix, Marginal and joint distribution, Conditional distribution and Independence of random vectors.

Multinomial distribution. Multivariate normal distribution, Marginal and conditional distributions. Sample mean vector and its distribution; Maximum likelihood estimates of mean vector and dispersion matrix. Tests of hypotheses about mean vector.

Wishart distribution and its properties; Hotelling's T^2 and Mahalanobis' D^2 statistics; Null distribution of Hotelling's T^2; Rao's U statistic and its distribution.

Multivariate analysis of variance; Wilk's lambda criterion and its properties; Discriminant analysis, Computation of linear discriminant function (LDF), Classification between two multivariate normal populations based upon LDF and Mahalanobis' D^2.

Canonical correlations; Factor analysis; Principal component analysis; Principal coordinate analysis; Cluster analysis, Similarities and Dissimilarities, Hierarchical clustering, Single and complete linkage methods.

Path analysis and computation of path coefficients; Multi-dimensional scaling; Categorical data analysis.

UNIT 5: Design of Experiments

Theory of linear estimation; Gauss Markoff theorem; Aitkin's transformation; Hypothesis testing and analysis of variance; Analysis of covariance; Restricted estimation; Random, fixed and mixed effects models.

Basic principles of design of experiments; Orthogonality; Contrast, Mutually orthogonal contrasts.

Completelyrandomized, Randomized complete block and Latin square designs; Missing plot technique; Orthogonal and mutually orthogonal Latin squares; Graeco Latin square designs.

Balanced incomplete block (BIB) designs, Symmetrical BIB designs, General properties, Analysis without and with recovery of intra-block information, Construction of BIB designs; Partially balanced incomplete block (PBIB) designs with two associate classes, General properties; Lattice designs; Alpha designs; Cyclic designs; Augmented designs; General analysis of block designs; Youden square designs; Cross-over designs.

Factorial experiments, Confounding in 2^n and 3^n factorial experiments, Partial and total confounding; Fractional factorial designs for symmetrical factorials.

Asymmetrical factorials. Split-plot and strip-plot designs. Combined analysis of experiments. Designs for fitting first order and second order response surfaces, Second order rotatable designs. Multiple comparison procedures; Sampling in field experiments.

UNIT 6: Sample Surveys

Complete enumeration *vs* sample survey; Probability sampling *vs* non-probability sampling; Sampling error; Sample space, Sampling design, Sampling strategy; Confidence interval.

Simple random sampling with and without replacement, Estimation of population mean and population proportion; Inverse sampling; Stratified random sampling, Optimum allocation, Number of strata, Construction of strata boundaries, Collapsing of strata. Determination of sample size.

Ratio, regression and product methods of estimation; Separate and combined ratio estimators; Cluster sampling; Multi-stage sampling with equal probability of selection of units at each stage; Two-phase sampling; Successive sampling over two occasions.

Sampling with varying probability with and without replacement, Probability proportional to size sampling - Cumulative method and Lahiri's method of selection; Horvitz Thompson estimator, Ordered and unordered estimators, Sampling strategies due to Midzuno-Sen and Rao-Hartley-Cochran; Inclusion probability proportional to size sampling.
Systematic sampling; Probability proportional to size systematic sampling.
Non-sampling errors, sources and classification, Non-response in surveys; Response error, Interpenetrating sub-samples, Imputation methods; Warner's randomized response technique. Unbiased ratio and regression type estimators; Multivariate ratio and regression type estimators.
Crop yield estimation surveys and crop cutting experiments. Agriculture census in India.

UNIT 7: Statistical Genetics

Physical basis of inheritance, Segregation and Linkage; Analysis of segregation, Detection and estimation of linkage for qualitative characters; Amount of information about linkage; Combined estimation, Disturbed segregation.
Gene and genotypic frequencies; Random mating; Hardy-Weinberg law of equilibrium; Disequilibrium due to linkage for two pairs of genes and sex-linked genes; Forces affecting gene frequency; Equilibrium between forces in large populations, Polymorphism; Fisher's fundamental theorem of natural selection; Random genetic drift; Effect of finite population size.
Polygenic system for quantitative characters; Average effect of gene; Average effect of gene substitution; Dominance deviation; Breeding value; Epistatic interaction deviation; Genotype- environment correlation, genotype-environment interaction and its application; Multiple allelism in continuous variations; Maternal effects; Different components of genetic variance and their partitioning; Effect of inbreeding on quantitative characters; Heterosis; Inbreeding depression; Effect of inbreeding on mean and variance of quantitative characters.
Resemblance between relatives; Phenotypic and genetic covariance between different relatives; Concept and estimation of genetic parameters; Heritability, Repeatability and Genetic correlation; Response due to selection, Selection index and its applications in plant and animal genetic improvement programmes; Correlated response to selection; Restricted selection index.
Mating designs; North Carolina designs and their analysis; Line × Tester Analysis; Diallel and partial diallel crosses including their construction and analysis.
Survival analysis; Phylogeny and analysis of molecular variance.

UNIT 8: Applied Regression Analysis

Simple and multiple linear regression models and their analysis; Estimation and testing of regression parameters, Sub-hypothesis testing, Restricted estimation; Polynomial regression: Use of orthogonal polynomials. Use of dummy variables. Regression with ordinal data. Logistic regression. Multiple and partial correlation coefficients; coefficient of multiple determinantion. Selection of variables, Stepwise and Stagewise regressions.
Regression diagnostics; Adequacy and validation of models. Examination of residuals - specification error, auto-correlation, Durbin-Watson statistic, Heteroscedasticity, Multi-collinearity. Weighted Least Squares, Outliers, Influential observations. Remedial measures - regression under non-normal errors, transformation of data, Generalized least squares, Model over-fitting, model under-fitting.
Parameter estimation in non-linear models.
Components of time-series. Fitting of different trend models. Auto-correlation and Partial Auto-Correlation functions. Correlogram. Determination of cyclical variations. Periodogram analysis. Linear Stationary models - Auto-Regressive, moving average and mixed processes. Linear non-stationary models. Forecasting.
Simultaneous equation models. Indirect Least Squares. Pooling of cross-section and time-series data. Demand and Supply curves. Determination of demand curves from market data. Engel's curves. Pareto curves.

UNIT 9: Optimization Techniques

Classical optimization techniques. Constrained optimization. Optimization and inequality. Cauchy-Sehwarz inequality, Jensen inequality, Markov inequality. Numerical methods of optimization. Direct Search method, Sequential Search method, Random Search method, Simplex Search method, Gradient method and Method of Steepest Ascent.

Linear Programming Techniques - Simplex method, Duality and sensitivity analysis. Two-person zero-sum game and linear programming; Integer Programming. Statistical applications.

Non-linear programming. Kuhn-Tucker conditions. Quadratic programming. Elements of Multiple objective programming. Dynamic programming. Optimal control theory.

Unit 10: Computer Applications

Computer Organization and Architecture- number system, input/output unit, memory unit, arithmetic logic unit and control unit.

Computer algorithms. Programming in C-Building blocks, control structures, arrays, pointers, dynamic memory allocation, file management. Data Structures-linked list, stack, queue, tree, graph, sorting and searching algorithms. Data Base Management System-definition and features, data models, relational database. Object oriented programming-encapsulation, inheritance, polymorphism with C++/JAVA. Networking-need, basic concepts. Value added network services – E-mail, on-line services, Internet, etc. Hyper-Text Markup Language (HTML), Building static and dynamic web pages.

Numerical analysis-interpolation, numerical integration, solution of ordinary differential equations, solution of linear and non-linear system of equations. Modeling and simulation-random number generation and testing, discrete simulation models, simulation of stochastic events and processes, design of simulation experiments, analysis of data generated by simulation experiments, validation of simulation models.

Soft computing tools - Artificial Neural Network, Support vector machines and probabilistic reasoning. Genetic algorithm, decision tree, Bayes classifiers, Fuzzy Logic. Rough Set. Hierarchical and non- hierarchical clustering algorithm. Simulation methods for various probability models. Resampling techniques: Jackknife and Bootstrap; Monte Carlo simulation.