University Grants Commission
NET Bureau

NET Syllabus

Subject: Statistics **Code:107**

Total Units: 10

UNIT I: Probability and Distributions

UNIT II: Real Analysis and Matrix Algebra

UNIT III: Sampling Methods and Design of Experiments

UNIT IV: Estimation Theory

UNIT V: Testing of Hypotheses

UNIT VI: Linear Estimation, Regression Analysis and Econometrics

UNIT VII: Time Series

UNIT VIII: Multivariate Analysis

UNIT IX: Stochastic Processes

UNIT X: Indian Statistical System and Research Methodology

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Unit I: Probability and Distributions

Basic concepts of probability, conditional probability, Bayes theorem, independent events. Random variables and distribution functions, expectation and moments, moment generating function. Standard discrete and continuous univariate distributions. Jointly distributed random variables, marginal and conditional distributions. Chebyshev inequality. Sampling distributions, transformation of random variables. Characteristic function and its properties. Modes of convergence of random variables, weak and strong laws of large numbers, central limit theorems (i.i.d. case).

Unit II: Real Analysis and Matrix Algebra

Real Analysis: Finite, countable and uncountable sets; sequences of real numbers, convergence of sequences, bounded sequences, monotonic sequences, Cauchy criterion for convergence; Series of real numbers, convergence, tests of convergence, alternating series, absolute and conditional convergence; Power series and radius of convergence; Functions of a real variable: Limit, continuity, monotone functions, uniform continuity, differentiability, Rolle's theorem, mean value theorems, Taylor's theorem, L′ Hospital's rule, Riemann integration and its properties, improper integrals.

Functions of two real variables: Limit, continuity, partial derivatives, total derivative, maxima and minima, saddle point, method of Lagrange multipliers, double and triple integrals and their applications.

Matrix Algebra: Vector spaces, subspaces, span, linear independence, basis and dimension, row space and column space of a matrix, rank and nullity, row reduced echelon form, trace and determinant, inverse of a matrix, systems of linear equations; Gram-Schmidt orthogonalization; Characteristic roots and characteristic vectors, characteristic polynomial, Cayley-Hamilton theorem, symmetric matrices, skew-symmetric matrices, orthogonal matrices and their

characteristic roots, positive definite and positive semi-definite matrices and their properties, quadratic forms.

Unit III: Sampling Methods and Design of Experiments

Sampling Methods: Simple random sampling, stratified random sampling, systematic sampling. Ratio and regression methods of estimation, cluster sampling for equal and unequal clusters, double sampling, sampling with varying probabilities with and without replacement. Nonnegative variance estimation, ordered and unordered estimators.

Design of Experiments: Analysis of variance in one-way and two-way classification (with and without interaction) in fixed effects model, principles of design of experiments, completely randomized design, randomized block design, Latin square design, missing plot techniques. Factorial experiments- $2^2, 2^3$, confounding in factorial experiments, Incomplete block designs and its intra-block and inter-block analysis, connectedness and orthogonality of block designs, balanced incomplete block design (BIBD), inter-block analysis and recovery of intra-block information of BIBD.

Unit IV: Estimation Theory

Point Estimation: Unbiasedness, consistency, method of moments and maximum likelihood estimators, efficiency, uniformly minimum variance unbiased estimators, Rao-Cramer lower bound, sufficiency, factorization theorem, minimal sufficiency, ancillary statistic, completeness, Rao-Blackwell theorem, Lehmann-Scheffe theorem, Basu's theorem.

Interval estimation: method of pivoting, confidence intervals for parameters in one sample and two sample normal populations. confidence intervals based on large samples.

Nonparametric Inference: Distributions of order statistics, empirical distribution function and its properties. Rank correlation coefficients of Spearman and Kendall.

Unit V: Testing of Hypotheses

Basic concepts, construction of tests: Neyman-Pearson lemma, families with monotone likelihood ratio. Uniformly most powerful, uniformly most powerful unbiased and uniformly most powerful invariant tests, likelihood ratio tests: applications to one sample and two sample problems. Wald's sequential probability ratio test, operating characteristic and average sample number.

Chi-square tests (goodness of fit, independence of attributes, homogeneity in contingency tables), sign test, Wilcoxon signed rank test, Mann-Whitney U-test, linear rank tests for location and scale problems, Kruskal-Wallis test.

Unit VI: Linear Estimation, Regression Analysis and Econometrics

Simple and multiple linear regression model, Gauss-Markov model, least squares and maximum likelihood estimation, testing of hypothesis related to regression parameters, Analysis of variance for linear model, R^2, adjusted R^2, tests of linear hypothesis, generalized and weighted least squares estimation, indicator/dummy variables, multicollinearity, heteroscedasticity, autocorrelation, Durbin-Watson test, logistic regression models.

Restricted regression estimation under exact, stochastic and mixed restrictions. Model with stochastic regressors and errors in variable model, instrumental variable estimator, simultaneous equations model, identification problem, two-stage least squares estimation, k-class estimator.

Unit VII: Time Series

Time series data, descriptive measures, autocovariance, autocorrelation functions (ACVF, ACF), and partial autocorrelation function (PACF), correlogram. Strong and weak stationarity, ergodicity. General linear process and Wold decomposition. Moving Average (MA), Autoregressive (AR) and mixed ARMA processes, stationarity and invertibility conditions. Yule–Walker equations. Identification, estimation and order selection of AR, MA and ARMA models, forecasting with stationary and invertible processes.

Non-stationary time series: random walk, ARIMA (p, d, q) models and parameter estimation. Frequency domain analysis: Spectral representation of time series, spectral density of AR, MA and ARMA processes, periodogram analysis and estimation of spectral density.

Unit VIII: Multivariate Analysis

Multivariate normal distribution and its properties, estimation of mean vector and covariance matrix in multivariate normal distribution, distribution of sample mean vector, Wishart distribution and its properties, distribution of simple, partial and multiple correlation coefficients and related tests, inference for parameters. Test of hypothesis related to mean vector and generalized T^2 statistic, discriminant analysis, principal component analysis, canonical correlation analysis.

Unit IX: Stochastic Processes

Markov chains with finite and countable state space, classification of states, Chapman-Kolmogorov equations, limiting behaviour of n-step transition probabilities, stationary distribution, Gambler's ruin problem, simple random walk. Poisson process, inter-arrival and waiting time distributions, Birth and death processes, M/M/1 queues.

Unit X: Indian Statistical System and Research Methodology

Indian Statistical System: Ministry of Statistics and Programme Implementation and its different wings, National Statistical Commission, National Statistics Office, census and large sample surveys. Contributions of P C Mahalanobis, P V Sukhatme, R C Bose, S N Roy, C R Rao, and other prominent Indian Statisticians.

Research Methodology: 'R' software: R as a calculator, functions and matrix operations, built in functions, missing data and logical operators. Conditional executions and loops; data management with sequences, repeats, sorting, ordering and strings; lists, factors, display and formatting. Data frames, data input and output, graphics and plots. Basics of programming, scripts and functions. $Latex$ and other word processing software.