



Unit 1

Real Analysis: Set theory, Bolzano Weierstrass theorem, Sequences and Series, Convergence, Sequences and Series of functions, Uniform Continuity, Differentiability, Riemann sums and Riemann Integral.

Linear Algebra: Vector Spaces, Subspaces, Linear Dependence, Basis, Dimension, Algebra of Linear Transformations, Algebra of Matrices, Rank and Determinant of Matrices, Linear Equations, Eigenvalues, Eigenvectors, Cayley-Hamilton theorem. Change of basis, Canonical forms, Diagonal forms, Triangular forms, Jordan forms. Inner Product Spaces, Orthonormal basis. Quadratic forms, Reduction and Classification of Quadratic forms.

Measure Theory: Measurable spaces, Extension of measure, Signed measure, Jordan-Hahn decomposition theorems. Lebesgue measure, Metric Spaces, Convergence, Continuity, Compactness, Connectedness, Monotone Convergence theorem, Fatou's Lemma, Dominated Convergence theorem, Absolute Continuity of two measures, Radon-Nykodym theorem, Product measures, Fubini's theorem.

Unit 2

Probability Theory: Sample Space, Discrete Probability, Independent Events, Bayes theorem. Random Variables and Distribution functions (Univariate and Multivariate), Expectation and Moments, Independent Random Variables, Marginal and Conditional Distributions.

Generating functions and Law of Large Numbers, Characteristic functions. Probability Inequalities (Chebyshev, Markov, Jensen), Modes of Convergence, Weak and Strong Laws of Large Numbers, Central Limit theorems (i.i.d. case).

Unit 3

Estimation: Methods of estimation, Properties of estimators, Confidence Intervals, Cramer- Rao Inequality, Rao-Blackwell theorem, Completeness, Lehmann-Scheffe theorem, Bhattacharya and Chapman -Robins Inequalities.

Unit 4

Testing of Hypotheses: Most Powerful and Uniformly Most Powerful tests, Likelihood Ratio Test, Locally Most Powerful test, Analysis of discrete data, Chi-Square test for goodness of fit, Small and Large sample tests, Invariance tests.

Non-parametric inference: Simple Non-Parametric tests for one and two sample problems, Rank Correlation and test for Independence.



Unit 5

Correlation: Partial and Multiple Correlation Coefficients and related tests.

Regression: Gauss Markov Models, Estimability of Parameters, Best Linear Unbiased Estimators, Simple and Multiple Linear Regressions, Elementary Regression Diagnostics, General Linear Model, Logistic Regression.

Unit 6

Multivariate Analysis: Multivariate normal distribution, Wishart distribution and its properties, Hotelling's

T² distribution, Mahalanobis D² statistic, Distribution of quadratic forms.

Data Reduction Techniques: Principal Component Analysis, Discriminant Analysis, Cluster Analysis, Canonical Correlation, Factor Analysis—EFA and CFA.

Unit 7

Design of Experiments: Analysis of Variance and Covariance, Fixed, Random and Mixed effects models, Randomized Block Designs, Latin-Square Designs, Mutually Orthogonal Latin-Squares and Youden Square Design. Connectedness and Orthogonality of Block Designs, Balanced Incomplete Block Design—Construction and Analysis. Partially Balanced Incomplete Block Design, 2k and 3k factorial experiments, Complete & Partial Confounding and construction, Fractional Factorial design—2^{n-k}.

Sampling Techniques—Simple random sampling, Stratified sampling and Systematic sampling, Probability Proportional to Size sampling, Cluster sampling, Multistage sampling, Ratio and Regression estimators, Horvitz–Thompson estimator.

Unit 8

Statistical Quality Control: Quality and Quality Improvement, Statistical Process Control, Control Charts for Attributes and Variables, Schewart Control charts, Operating-Characteristic Function, Process Capability analysis, Process capability ratios, Acceptance Sampling Plans, Dodge–Romig Sampling Plans – AOQL, ATI and LTPD – Continuous Sampling Plans by Attributes, CSP–1, CSP–2 and CSP–3, CUSUM Control Charts.

Reliability: Basics of Reliability—Quality and Reliability—Reliability Modelling. Concepts of Series and Parallel Systems.

Unit 9

Survival Analysis: Survival and Hazard functions, Types of Censoring. Kaplan-Meier Estimator, Cox PH model, Parametric Models.



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Bayesian Inference: Bayes theorem, Conjugate, Improper and Jeffreys' Prior, Loss and Risk functions, Posterior Predictive Distribution, Bayesian Point and Interval Estimates.

Unit 10

Operations Research: Linear Programming Problems, Simplex and Dual Simplex methods, Sensitivity analysis, Integer Programming, Non-Linear Programming, Kuhn-Tucker Condition, Decision Tree and Bellman Principle of Optimality.

Queuing Theory: Elementary Queuing and Inventory Models, Steady-State solutions of Markovian Queuing Models, M/M/1 Model, M/M/1 with limited waiting space, Markov Chains with finite and countable state space, Classification of states, Limiting behaviour of n-step transition probabilities, Stationary distribution, Poisson and Birth-and-Death Processes.