Syllabus for PhD Entrance Examination

Mathematics & Statistics

Linear Algebra: Finite dimensional vector spaces over real or complex fields; Linear transformations and their matrix representations, rank and nullity; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton Theorem, diagonalization, Jordan canonical form, symmetric, skew-symmetric, Hermitian, skewHermitian, orthogonal and unitary matrices; Finite dimensional inner product spaces, GramSchmidt orthonormalization process, definite forms.

Numerical Analysis: Numerical solutions of algebraic and transcendental equations: bisection, secant method, Newton-Raphson method, fixed point iteration; Interpolation: error of polynomial interpolation, Lagrange and Newton interpolations; Numerical differentiation; Numerical integration: Trapezoidal and Simpson's rules; Numerical solution of a system of linear equations: direct methods (Gauss elimination, LU decomposition), iterative methods (Jacobi and Gauss-Seidel); Numerical solution of initial value problems of ODEs: Euler's method, Runge-Kutta methods of order 2.

Linear Programming: Linear programming problem and its formulation, convex sets and their properties, graphical method, basic feasible solution, simplex method, two phase methods; infeasible and unbounded LPP's, alternate optima; Dual problem and duality theorems; Balanced and unbalanced transportation problems, Vogel's approximation method for solving transportation problems; Hungarian method for solving assignment problems.

Probability and Probability Distributions: Random experiments, sample space, events, Classical and relative frequency approaches to probability, joint probability, marginal probability, independent events, Conditional probability, Polya's urn scheme, Bayes' Theorem, Random variable, probability mass(density) function, standard discrete and continuous distributions: Binomial, Poisson, Negative Binomial, Hypergeometric, Geometric distributions, Uniform distribution, Exponential distribution, Normal distribution, Chi-square distribution, Student's t distribution, F-distribution, Expectation/mean, variance, moments, moment generating function, and probability generating function.

Estimation and Hypothesis Testing: Sampling distribution, central limit theorem, sample size determination, estimation of population parameters, method of moments, method of maximum likelihood estimation, interval estimation; Testing of hypothesis, null and alternative hypothesis, test statistic, one-tailed and two tailed test, Type-I and Type-II error, power of the test, hypothesis tests for population mean (σ known), tests for population proportion, tests for population mean (σ unknown), t-test for independent samples and paired samples, tests for equality of variances, Chi-square test for goodness of fit, Chi-square test for independence of attributes.

Regression Analysis: Simple linear regression, model building, estimation of parameters using OLS, interpretation of coefficients, coefficient of determination, hypothesis testing for regression coefficient, Test for overall model (F-test), Residual analysis, outlier analysis, confidence interval for regression coefficients, multiple linear regression (MLR), partial and multiple correlations; regression with dummy variables; forward, backward and stepwise regressions.