

PH. D. ENTRANCE

MATHEMATICS

Unit 1: Algebra

Finite dimensional vector space; linear transformations and their matrix representations, rank; system of linear equations, eigen values and eigen vectors, minimal polynomial, Cayley-Hamilton Theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices.

Subgroups, rings and fields.

Books:

- (i). I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd. New Delhi, 1975.
- (ii). P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press; Indian Edition, 1997.
- (iii). Gilbert Strang, Linear Algebra and its applications, Thomson's books, 2006.

Unit 2: Mathematical Analysis

Analytic functions, conformal mappings, bilinear transformations; complex integration, Cauchy's integral theorem and formula, Liouville's theorem, Taylor and Laurent's series, residue theorem.

Sequences and series of functions, uniform convergence, power series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss.

Banach spaces, principle of uniform boundedness, Hilbert spaces, orthonormal bases, bounded linear operator.

Books:

- (i). Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar, Inc. New York, 1975.
- (ii). A.J. White, Real Analysis; an introduction. Addison-Wesley Publishing Co., Inc., 1968.
- (iii). Churchill, R.V. and Brown, J.W., Complex Variables and Applications McGraw Hill Publishing Company, 1990.
- (iv). E. Kreyszig: Introductory Functional Analysis with Applications, John Wiley and Sons, New York, 1978.

Unit 3: Differential Equation

First order ordinary differential equations, existence and uniqueness theorems, system of linear first order ordinary differential equations, linearly differential equations of higher order with constant coefficients, linear second order differential equations with variable coefficients, methods of Laplace transforms for solving ordinary differential equations.

Linear and quasilinear first order partial differential equations, method of characteristic, second order linear equations in two variables and their classification, solutions of Laplace, wave and diffusion equations in two variables.

Books:

- (i) G.F. Simmons, Differential Equations, Tata McGraw-Hill , 1993.
- (ii) Zafar Ahsan, Differential Equations and their applications, PHI Learning Private Ltd, 2010.
- (iii) I.N. Snedden, F. John, P. Prasad etc. Partial Differential Equations, Graduate studies.

Unit 4: Numerical Methods

Numerical solution of algebraic and transcendental equations, bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation, error of polynomial interpolation, Lagrange Newton interpolations, numerical differentiation, numerical integration, Trapezoidal and Simpson's rules, Gauss-Legendre quadrature, method of undetermined parameters, least square polynomial approximation, numerical solution of system of linear equations: direct methods(Gauss elimination, approximation, L U decomposition), iterative methods(Jacobi and Gauss-Siedel), matrix- eigen value problems, powermethod, numerical solution of ordinary differential equations, initial value problems, Taylor series methods, Euler's method, Runge-Kutta methods.

Books:

- (i). Introductory Method of Numerical Analysis : Sastry, PHI
- (ii). Numerical Method : Balaguruswamy, TMH
- (iii). Numerical Methods for Scientific & Engineering Computations: Jain, Iyengar, Jain, New Age International.

Unit 5: Differential Geometry and fluid Mechanics

Basic concept of tensor algebra; Christoffel symbols and covariant differentiation, space curves, Tangent normal, binomial, curvature and torsion of space curves, serret-frenet formulae; surface, curvilinear equations of curve on the surface, Tangent and normal, family of surfaces.

Viscous and non viscous fluid, equation of motion, equations of continuity, conservation of energy, Reynodd number, Richardson's number, parallel flows, shear flows.

Books:

- (i) Gupta, Pandey, Malik, Tensors and Differential Geometry, Pragati Prakashan.
- (ii) Louis N. Hand and Janet D. Finch, Analytical Mechanics, Cambridge University Press, 1998.
- (iii) Luther Pfahler Eisehart, An Introduction to Differential Geometry, Maugham Press, 2008.

PHD ENTRANCE
STATISTICS AND OPERATIONS RESEARCH

UNIT 1: Descriptive statistics and exploratory data analysis:

Statistical Methods: Concepts of statistical population and sample, quantitative and qualitative data, Nominal, ordinal and time series data, discrete and continuous data: Presentation of frequency distributions by histogram and frequency polygon, cumulative frequency distributions and ogive curve. Measures of location and dispersion, measures of skewness and kurtosis, absolute moments and factorial moments, Sheppard corrections. Bivariate data, scatter diagram, principle of least squares. Simple and multiple Correlation and Regression analysis, Theory of attributes.

UNIT 2: Probability and probability distribution:

Definition of Probability. Classical and relative frequency approach to probability; Bayes theorem. Random variables and distribution functions (univariate and multivariate); expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic and generating functions. Probability inequalities (Tchebyshef, Markov, Jensen). Modes of convergence, weak and strong laws of large numbers, Central Limit theorems (i.i.d. case). Markov chains with finite and countable state space, classification of states, limiting behaviour of n-step transition probabilities, stationary distribution. Probability distributions: Binomial, Poisson, exponential, Negative Binomial, Geometric, Hyper geometric, Normal, uniform, beta, gamma, Cauchy and Laplace.

UNIT3: Statistical Sample Survey:

Sample Surveys: Concepts of Population and sample. Complete enumeration vs sampling. Need for sampling. Principal and organisational aspects in the conduct of a sample survey. Probability sampling design. Properties of a good estimator. Sampling errors. Basic sampling methods: Simple random sampling with or without replacement, Determination of sample size. Probability proportional to size sampling (with replacement). Stratified random sampling: Different allocations. Post-stratification. Ratio and Regression methods of estimation, optimality of regression estimator. Linear and circular systematic sampling, Cluster sampling, Two stage sampling (Sub-sampling) with equal first stage units. Non sampling errors.

UNIT4: Statistical Inference

Tests of significance: Null and alternative hypotheses, level of significance, Type I and Type II errors, critical region and p-value. Large sample tests, use of CLT for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard

deviations. Tests of significance based on t, F and Chi-square distributions, Analysis of variances and Design of experiment.

Estimation: Parametric space, sample space, point estimation. Requirements of good estimator: Consistency, unbiasedness, efficiency, sufficiency and completeness. Minimum variance unbiased (MVU) estimators. Cramer-Rao inequality. Minimum Variance Bound (MVB) estimators, Interval estimation: Confidence intervals for the parameters of various distributions. Confidence intervals for difference of means and for ratio of variances.

UNIT 5: Operational Research:

Introduction to OR, Linear Programming: Models, graphical solution, simplex method Big M, and two phase technique. Concept of duality, dual simplex method post-optimality analysis. Revised simplex method, Transportation and Assignment problems. Integer programming, Quadratic programming, CPM and PERT networking problems. Replacement model, Game Theory, Decision Theory, Deterministic and Stochastic inventory models, Queuing theory and sequencing problems. Dynamic Programming.

SUGGESTED READINGS:

1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asis Publishing House.
2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8th Edn. World Press, Kolkata.
4. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn.(Reprint), Sultan Chand and Sons.
5. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.
2. Hadley, G. (2002): Linear Programming (Reprint). Narosa Publishing House.
3. Hillier, F.S. and Lieberman, G. J. (2001): Introduction to Operational Research, 7th Edn. Irwin.
4. Kantiswarup, Gupta, P.K. and Manmohan (2008): Operations Research, 13th Edn. Sultan Chand