School of Mathematics, IISER-TVM

Syllabus for PhD Admission Test

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1. Test wil be of 2 and a half hours duration.
2. Test paper will have two parts; Part A and Part B.
3. Part A will consists of 8 fill in the blank type questions worth 2.5 marks each. There is no choice in Part A. There will be two questions from each of the four sections mentioned below.
4. Part A answer sheets will be collected after 30 minutes.
5. Part B will consists of 12 descriptive type questions of which 8 have to be answered. Each question is worth 5 marks. There will be 3 questions of equal weightage from each of the four sections mentioned below.

Algebra

Groups, subgroups, normal subgroups and homomorphism theorems, automorphisms; cyclic groups, permutation groups, Cayley's theorem, Sylow's theorem and its applications. Rings, ideals, prime and maximal ideals, quotient rings, Euclidean domains, principal ideal domains and unique factorization domains, finite fields.

Finite dimensional vector spaces; Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigen vectors, minimal polynomial, Cayley-Hamilton Theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices; Finite dimensional inner product spaces, Gram-Schmidt orthonormalization process.

Analysis

Real valued functions of a real variable; Continuity and differentiability; Sequences and series of functions, uniform convergence, power series, Fourier series; functions of several

variables, maxima, minima; Riemann integration, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, connectedness, compactness.

Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions; analytic functions, conformal mappings, bilinear transformations; complex integration: Cauchy's integral theorem and formula; Liouville's theorem, Taylor and Laurent's series; residue theorem and applications for evaluating real integrals.

Applied Mathematics

First order ordinary differential equations, existence and uniqueness theorems; systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients; method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality.

Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; solutions of Laplace, wave and diffusion equations in two variables; Fourier series and Fourier transform and Laplace transform methods of solutions for the above equations.

Numerical solution of algebraic and transcendental equations: bisection, secant method, Newton-Raphson method, fixed point iteration.

Other Topics

Elementary combinatorics; permutations, combinations, binomial/multinomial theorems, recursions.

Probability/Statistics; Probability space, conditional probability, Bayes theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments; measures of central tendency, measures of dispersion, central limit theorem.

Operations Research; optimisation in two variables, simplex method.

Suggested Books for Reading

1. Herstein, I.N., Topic in Algebra, 2e, Vikas Publishing House Pvt. Ltd, NewDelhi, 1976.

2. Hoffman, K., and Kunze, R., Linear Algebra, Prentice Hall of India Pvt Ltd., New

Delhi, 1978.

3. Kumaresan, S., Linear Algebra–A Geometric Approach, Prentice Hall of India, 2000.

4. Rudin, W., Principles of Mathematical Analysis, 3e, International Edition, McGraw-Hill, 1976.

5. Apostol,T.M., Calculus - Vol. 1 & 2, 2nd Edn., Wiley India, 2003.

6. Goldberg, R.R., Methods of Real Analysis, John Wiley & Sons, Inc., New York-London-Sydney, 1976.

7. Churchill, R.V., and Brown, J.W., Complex Variables and Applications, 5th Edition, McGraw-Hill, 1990.

8. Simmons, G.F., Introduction to Topology and Modern Analysis, Tata McGraw Hill, 2003.

9. Conte, S.D., and de Boor C., Elementary Numerical Analysis, an Algorithmic Approach, McGraw-Hill, 2005.

10. Coddington, E.A., Introduction to Ordinary Differential Equations, Dover Publications, 1989.

11. Sneddon, I.N., Elements of Partial Differential Equations, McGraw Hill, 1957.

12. Rohatgi, V.K., and Md. Ehsane Saleh, A.K., An Introduction to Probability and Statistics, Wiley Student Edition, 2e, 2006.

13. Hillier, F.S., and Lieberman, G.J., Introduction to Operations Research, Holden-Day, Inc., Oakland, Calif., 1980.