MATHEMATICS DEPARTMENT

Syllabus for Written Test to Ph. D Program, June 2018.

Group A: (30 Marks: MCQ)

1) Logical Reasoning, Data Analysis & Interpretation and Verbal Ability:

Number Sequence Completion; Pattern Completion; Sets based on grouping and patterns; Seating Arrangement problems; Circular Arrangements; Relational problems; Selection and Conditionals; Mapping and best routes; Miscellaneous sets consisting of formal logic, testing, sports events and other critical reasoning, Data Analysis, Data Interpretation, Data Sufficiency, Reading Comprehension, Verbal Logic, Vocabulary, Grammar Correction.

2) General information on Science and its interface with society to test the candidate's awareness of science, aptitude of scientific and quantitative reasoning, Common elementary Computer Science, Programming instructions, simple algorithms and computational methods.

Group B: (40 Marks: MCQ)

This section will cover fundamentals from Analysis, Algebra & Applied Mathematics.

Group C: (30 Marks: Descriptive)

Candidate is required to answer from only one of the groups. However, his/her selection may not be limited to that specialization only.

Group1:

Real Analysis **:** Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral, Improper Integrals. Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral. Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, inverse and implicit function theorems. Metric spaces, compactness, connectedness. Normed linear Spaces. Spaces of continuous functions as examples.

Complex Analysis : Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem. Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations.

Linear Algebra : Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis.

Quadratic forms, reduction and classification of quadratic forms.

Numerical Analysis **:** Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, Finite differences, Lagrange, Hermite and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

Group 2:

Ordinary Differential Equations : Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs. General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function.

Partial Differential Equations: Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs. Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations.

Numerical Analysis **:** Numerical solutions of non-linear equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear equations using Gauss elimination and Gauss-Seidel methods, Lagrange, Hermite and spline interpolation, Finite differences, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

Fluid Mechanics: Fluids and their properties, Lagrangian and Eulerian methods of description, governing equations of fluid motion, path, stream and streak lines, velocity potential, equations of continuity in Lagrangian and Eulerian methods, boundary surface, Euler's equations of motion, Bernoulli's theorem and its applications, Navier-Stokes equations, steady motion of a viscous fluid between two parallel planes and steady flow through cylindrical pipes.