TEERTHANKER MAHAVEER UNIVERSITY

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Delhi Road, Moradabad (U.P.)

SYLLABUS FOR RESEARCH APTITUDE TEST IN MATHEMATICS

The syllabus for Research Aptitude Test (RAT) in Mathematics is divided in two parts viz. Part A & Part B described below:

PART – A

Part A of the RAT shall be designed to assess the research skills/aptitude of the candidate consisting of questions from the following areas:

1. **Research Methodology:** meaning, characteristics, and ethical issues in research; types of research; research methods

2. **Logical Reasoning:** arguments, deductive and inductive research; logical and Venn diagram; inferences; analogies.

3. **Data Interpretation:** interpretation of data; mapping and analysis of data, tools for data analysis; quantitative and qualitative research.

4. **General Awareness about Basic Science:** basic science up to the level of SSC.

5. **Mathematical Reasoning:** number series, letter series, codes; relationships, classification.

PART – B

Part-B of RAT is designed to assess subject specific knowledge of the candidate covering syllabus given as below:

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations; complex integration: Cauchy's integral theorem and formula; Liouville's theorem, maximum modulus principle; Taylor and Laurent's series; Residue theorem and applications for evaluating real integrals.

Ordinary Differential Equations: 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.

Algebra: Normal Subgroups and homomorphism theorems, automorphisms; Group actions, Sylow's theorem and their applications; Euclidean domains, Principle ideal domains and unique factorization domains. Prime ideals and maximal ideals in commutative rings; Fields, Finite fields.

Numerical Analysis; Numerical solution of algebraic and transcendental equations: bisection, secant method , Newton-Raphson method, Fixed point iteration; interpolation; error of polynomials interpolation, Lagrange, Newton interpolations; Numerical differentiation; Numerical integration: Trapezoidal and Simpson rules, Gauss Legendre quadrature, method of undetermined parameters; least square polynomials approximation; Numerical solution of systems of linear equations: direct methods(Gauss elimination, LU decomposition); iterative methods(Jacobi and gauss-Seidel); Matrix eigenvalue problems: power method, Numerical solution of ordinary differential equations: initial values problems, Taylor series methods, Euler's method, Runge–Kutta methods.

Partial Differential Equation: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems; solution of Laplace, wave and diffusion equations in two variables; Fourier series and Fourier transform and Laplace transform methods of solutions for the above equations.

Mechanics: Virtual work, Lagrange's equations for holonomic systems, Hamiltonian equation, Equation of continuity, Equation of motion in cylinder, Vortices.

Topology: Basic concepts of topology, Product topology, Connectedness, Compactness, Countability and separation axioms, Urysohn's Lemma.

Probability and Statistics: Probability space, conditional probability, Bay's theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments; weak and strong law of large numbers ,central limit theorem; Sampling distributions, UMVU estimators, maximum likelihood estimators, Testing of hypotheses, Standard parametric tests based on normal, X^2, t , F-distributions; Linear regression; Interval estimation.

Linear programming: Linear programming problem and its formulation, convex sets and their properties, graphical method, basic feasible solution, Simplex method, Big- M and two phase method; infeasible and unbounded LPP's, alternate optima; Dual problems and duality theorems, dual simplex method and its application in post optimality analysis; Balanced and unbalanced transportation problems, u-u method for solving transportation problems; Hungarian method for solving assignment problems, Assignment problems, Transportation problems.

Calculus of Variation and Integral Equations: Variation problems with fixed boundaries; sufficient conditions for extremum, linear integral equations of Fredholm and Volterra type and their iterative solutions.