JRF IN MATHEMATICS 2026

Syllabus

Test Codes: MTA & MTB

There will be two tests, **MTA** and **MTB**, each of **2 hours duration**, conducted in the forenoon and afternoon respectively. Candidates will be judged based on their performance in **both** the tests.

Topics for MTA (Forenoon Examination)

- Real Analysis
- Measure and Integration
- Complex Analysis
- Ordinary Differential Equations
- Functional Analysis

Topics for MTB (Afternoon Examination)

- Abstract Algebra
- Linear Algebra
- General Topology
- Elementary Number Theory and Combinatorics
- Probability Theory

Outline of the Syllabus

1. Real Analysis

Sequences and series of real numbers and functions, continuity and differentiability of real-valued functions of one variable and applications, uniform convergence, Riemann integration, improper integrals, continuity and differentiability of real-valued functions of several variables, partial derivatives and mixed partial derivatives, total derivative, Taylor series for functions of several variables, maxima and minima.

2. Measure and Integration

Lebesgue measure on $\mathbb{R}^n$, measurable functions, Lebesgue integral, convergence almost everywhere, monotone convergence theorem, dominated convergence theorem, Fubini's theorem.

3. Complex Analysis

Analytic functions, Cauchy's theorem and Cauchy integral formula, maximum modulus principle, Laurent series, singularities, theory of residues, contour integration.

4. Ordinary Differential Equations

First order ordinary differential equations and their solutions, singular solutions, initial value problems for first order ODEs, general theory of homogeneous and nonhomogeneous linear differential equations, second order ODEs and their solutions.

5. Functional Analysis

Normed linear spaces, Banach spaces, Hilbert spaces, compact operators. Standard examples such as $C[0,1]$ and $L^p[0,1]$. Continuous linear maps (bounded linear operators). Hahn–Banach theorem, open mapping theorem, closed graph theorem, uniform boundedness principle.

6. Algebra

Groups, homomorphisms, normal subgroups and quotient groups, isomorphism theorems, finite groups, symmetric and alternating groups, direct products, structure of finite Abelian groups, Sylow theorems. Rings and ideals, quotient rings, homomorphism and isomorphism theorems, maximal ideals, prime ideals, integral domains, field of fractions, Euclidean rings, principal ideal domains, unique factorization domains, polynomial rings. Fields, characteristic of a field, algebraic extensions, roots of polynomials, separable and normal extensions, finite fields.

7. Linear Algebra

Vector spaces, linear transformations, characteristic roots and characteristic vectors, systems of linear equations, inner product spaces, diagonalization of symmetric and Hermitian matrices, quadratic forms, canonical forms, spectral theorem.

8. General Topology

Topological spaces, continuous functions, connectedness, compactness, separation axioms, product spaces, metric spaces, uniform continuity, Baire category theorem.

9. Elementary Number Theory and Combinatorics

Divisibility, congruences, standard arithmetic functions, permutations and combinations.

10. Probability Theory

Basic definitions and ideas such as random experiment, sample space and event, Boole's inequality and Bonferroni inequality, Conditional probability and its basic properties, Bayes theorem and related examples, Independent events, Random variables and their distribution function, Expectation and moments of random variables, Markov, Chebyshev and Jensen's inequality, Various modes of convergence, Weak law of large numbers, strong law of large numbers, CLT for i.i.d sequences.