

JRF IN MATHEMATICS 2023
Syllabus
Test Codes: MTA & MTB

There will be two tests MTA and MTB of 2 hours duration each in the forenoon and in the afternoon. Topics to be covered in these tests are given below:

1. **Topics for MTA (Forenoon examination):** Real Analysis, Measure and Integration, Complex Analysis, Ordinary Differential Equations, Functional Analysis.
2. **Topics for MTB (Afternoon examination):** Algebra, Linear Algebra, General Topology, Elementary Number Theory and Combinatorics.

Candidates will be judged based on their performance in both the tests.

OUTLINE OF THE SYLLABUS

1. **Real analysis:** Sequence 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.
2. **Lebesgue integration:** Lebesgue measure on \mathbb{R}^n , measurable functions, Lebesgue integral, convergence almost everywhere, monotone and dominated convergence theorems, 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 ODE and their solutions, singular solutions, initial value problems for first order ODE, general theory of homogeneous and nonhomogeneous linear differential equations, second order ODE and their solutions.
5. **Functional analysis:** Normed linear spaces, Banach spaces, Hilbert spaces, compact operators. Knowledge of some standard examples like $C[0, 1]$, $L^p[0, 1]$. Continuous linear maps (bounded linear operators). Hahn-Banach theorem, open mapping theorem, closed graph theorem, uniform boundedness principle.
6. **Abstract algebra:** Groups, homomorphisms, normal subgroups and quotients, isomorphism theorems, finite groups, symmetric and alternating groups, direct product, structure of finite Abelian groups, Sylow theorems. Rings and ideals, quotients, 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.
8. **General topology:** Topological spaces, continuous functions, connectedness, compactness, separation axioms, product spaces, complete metric spaces, uniform continuity, Baire category theorem.
9. **Elementary number theory and combinatorics:** Divisibility, congruences, standard arithmetic functions, permutations and combinations, combinatorial probability.