JSPM UNIVERSITY

JSPM UNIVERSITY PUNE



SYLLABUS

RPET 2026

Research Program Entrance Test

Subject Concerned Syllabus Mathematics

1: **Algebra**: Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Sylow Theorems, Rings, principal ideal domain, unique factorization domain, Fields, Field Extension, Finite Fields.

Fundamental theorem of arithmetic, divisibility in Z, congruences, Chinese Remainder Theorem, Euler's Ø- function, primitive roots.

2: **Linear Algebra**: Vector Spaces, linear dependence, basis, dimension, algebra of linear transformations, Primary decomposition theorem, Cayley Hamilton theorem, Hermitian and Unitary transformations, canonical forms, Spectral theorem. Inner product spaces, orthonormal basis. Quadratic forms, reduction and classification of quadratic forms.

3: **Real Analysis**: Real valued functions of one variable, bounded functions, limits of functions, monotonic functions, continuous functions, uniformly continuous functions, sequences of functions, series of functions, differentiability of function, Rolle's theorem, Mean value theorem, Riemann integral and properties, Fundamental theorem of Calculus, Taylor series, Fourier series, topology of R^n (convergence, continuity, compactness, connectedness, completeness), Bolzano-Weierstrass theorem, Cantor's intesection theorem, Heine-Borel theorem, Weierstrasss approximation theorem, Baire category theorem.

4: **Complex Analysis**: Algebra of complex numbers, Power series and radius of convergence, analytic functions, chain rule, branch points, Cauchy-Riemann equations, Conformal mappings, Mobius transformations, complex integration, Contour integral, Riemann-Stieltjes integral, Fundamental theorem of algebra, maximum modulus theorem, winding number, Cauchy theorem and integral formula and its applications, Liouville's theorem, Morera's theorem, Open mapping theorem, Goursat's theorem, classification of singularities, Laurent series, residue theorem.

5: **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., Picard's iteration theorem, Boundary value problems, variation of parameters, Sturm-Liouville boundary value problem, Green's function.

6: **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.

7: **Advanced Calculus**: Functions of several variables, Limit, Continuity, Differentiability, Chain rule, maxima and minima, Implicit function theorem, Inverse function theorem.

8: **Measure and Integration**: Measure on the real line, Lebesgue outer measure, Measurable sets, Measurable functions, Borel and Lebesgue measurability, Integration of measurable functions, functions of bounded variation, Lebesgue's differentiation theorem, L^p spaces, convex functions, Jensen's inequality, Hölder's and Minkowski's inequality, completness of L^p spaces.

9: **Functional Analysis**: Normed linear spaces, continutity of linear maps, Hahn-Banach theorem, Banach spaces, Uniform boundedness principle, Closed graph and Open mapping theorems, Bounded inverse theorem, Spectrum of bounded operator, Duals and Transposes, Duals of $L^p([a, b])$ and $C([a, b])$, Inner product spaces, Orthonormal sets, Approximation and optimization, Projection, Riesz-representation theorem, Bounded operators and adjoints, self adjoint, Normal, Unitary operators.

10: **Topology**: Topological of metric spaces, Continuity, Convergence, Homeomorphism, Compactness, Connectedness, basis, dense sets, Subspaces, Product Spaces, Quotient spaces, Tychonoffs theorem, Urysohns metrization theorem.

11: **Discrete Mathematics**: Partially ordered sets, Lattices, Complete lattices, Distributive lattices, Complements, Boolean algebra, Boolean expressions, Application to switching circuits, Elements of Graph Theory, Eulerian and Hamiltonian graphs, Planar graphs, Directed graphs, Trees, Permutations and Combinations, Pigeonhole principle, Principle of inclusion and exclusion.

12. Numerical Analysis: Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, 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.