

## Syllabus for Entrance Test of M.Sc. (Mathematics) 2023

**Algebra** : Nature of the roots of an equation, Descartes's rule of signs. Solutions of cubic equations (Cardon's method). Biquadratic equations and their solutions. Relations between the roots and coefficients of general polynomial equation in one variable. Solutions of polynomial equations. Common roots and multiple roots. Transformation of equations. (04 Marks)

**Calculus**:  $\epsilon$ - $\delta$  definition of the limit of a function. Basic properties of limits, Continuous functions and classification of discontinuities. Differentiability. Successive differentiation. Leibnitz theorem. Maclaurin and Taylor series expansions. Limit continuity and Differentiability of real valued functions of two variables. Partial differentiation. Total Differentials; Composite functions & implicit functions. Change of variables. Homogenous functions & Euler's theorem on homogeneous functions. Taylor's theorem for functions of two variables. Schwarz and Young's theorem. Implicit function theorem. Maxima, Minima and saddle points of two variables. Lagrange's method of multipliers. (05 Marks)

**Trigonometry**: De Moivre's Theorem and its Applications. Expansion of trigonometrical functions. Direct circular and hyperbolic functions and their properties. Inverse circular and hyperbolic functions and their properties. Logarithm of a complex quantity. Gregory's series. Summation of Trigonometry series. (03 Marks)

**Real Analysis**: Sequence & Series, Boundedness of the set of real numbers; least upper bound, greatest lower bound of a set, neighborhoods, interior points, isolated points, limit points, open sets, closed set, interior of a set, closure of a set in real numbers and their properties. Bolzano-Weierstrass theorem, Open covers, Compact sets and Heine-Borel Theorem, Riemann integral, Integrability of continuous and monotonic functions, The Fundamental theorem of integral calculus. Mean value theorems of integral calculus. Improper integrals and their convergence, Comparison tests, Abel's and Dirichlet's tests, Frullani's integral, Integral as a function of a parameter. Continuity, Differentiability and integrability of an integral of a function of a parameter. Definition and examples of metric spaces, neighborhoods, limit points, interior points, open and closed sets, closure and interior, boundary points, subspace of a metric space, equivalent metrics, Cauchy sequences, completeness, Cantor's intersection theorem, Baire's category theorem, contraction Principle (10 Marks)

**Groups and Rings**: Groups, Subgroups and Quotient groups with example and their properties, Normal subgroups, Homomorphism, isomorphism, automorphism and inner automorphism of a group. Automorphisms of cyclic groups, Permutations groups. Even and odd permutations. Alternating groups, Cayley's theorem, Center of a group and derived group of a group. Introduction to rings, subrings, integral domains and fields, Characteristics of a ring. Ring homomorphisms, ideals (principle, prime and Maximal) and Quotient rings, Field of quotients of an integral domain. (10 Marks)

**Complex Analysis**: Extended Complex Plane, Stereographic projection of complex numbers, continuity and differentiability of complex functions, Analytic functions, Cauchy-Riemann equations. Harmonic functions. Mappings by elementary functions: Translation, rotation, Magnification and Inversion. Conformal Mappings, Mobius transformations. Fixed points, Cross ratio, Inverse Points and critical mappings. (08 Marks)

**Linear Algebra**: Vector spaces, subspaces and their properties. Quotient space, Linear transformations and linear forms on vector spaces, Vector space of all the linear transformations. Dual Spaces, Bidual spaces, annihilator of subspaces of finite dimensional vector spaces, Null Space, Range space of a linear transformation, Rank and Nullity Theorem, Algebra of Linear Transformation, Minimal Polynomial of a linear transformation, Singular and non-singular linear transformations, Matrix of a linear Transformation, Change of basis, Eigen values and Eigen vectors of linear transformations. (10 Marks)



**Solid Geometry:** Sphere: Plane section of a sphere. Sphere through a given circle. Intersection of two spheres, radical plane of two spheres. Co-axial system of spheres. Cones: Right circular cone, enveloping cone and reciprocal cone. Cylinder: Right circular cylinder and enveloping cylinder.

**Differential Equations:** Ordinary simultaneous differential equations. Solution of simultaneous differential equations involving operators  $x$  ( $d/dx$ ) or  $t$  ( $d/dt$ ) etc. Simultaneous equation of the form  $dx/P = dy/Q = dz/R$ . Total differential equations. Condition for  $Pdx + Qdy + Rdz = 0$  to be exact. General method of solving  $Pdx + Qdy + Rdz = 0$  by taking one variable constant. Method of auxiliary equations. Partial differential equations: Formation, order and degree, Linear and Non-Linear Partial differential equations of the first order: Complete solution, Singular solution, General solution, Solution of Lagrange's linear equations, Charpit's general method of solution. Compatible systems of first order equations, Jacobi's method. Classification of linear partial differential equations of second order. Method of separation of variables: Solution of Laplace equation, Wave equation, Diffusion (Heat) equation.

(07 Marks)

**Vector Calculus:** Scalar and vector product of three vectors, product of four vectors. Reciprocal vectors. Vector differentiation. Scalar valued point functions, vector valued point functions, derivative along a curve, directional derivatives. Vector integration; Line integral, Surface integral, Volume integral. Theorems of Gauss, Green & Stokes and problems based on these theorems.

(08 Marks)

**Laplace Transform:** Existence theorem for Laplace transform, Linearity of the Laplace transforms, Shifting theorems, Laplace transform of derivatives and integrals, Differentiation and integration of Laplace transform, Convolution theorem, Inverse Laplace transform, convolution theorem, Inverse Laplace transform of derivatives and integrals, solution of ordinary differential equations using Laplace transform.

(06 Marks)

**Programming in C :** Programmer's model of a computer, Algorithms, Flow charts, Data types, Operators and expressions, Input / outputs functions. Decision control structure: Decision statements, Logical and conditional statements, Implementation of Loops, Switch Statement & Case control structures. Functions, Preprocessors and Arrays.

(07 Marks)

(06 Marks)

**Numerical Analysis:** Finite Difference operators and their relations. Interpolation with equal intervals and unequal intervals: Newton's divided difference, Lagrange's Interpolation formulae, Hermite Formula. Central Differences: Gauss forward and Gauss's backward interpolation formulae, Sterling, Bessel Formula. Numerical Integration: Newton-Cote's Quadrature formula, Chebychev formula, Gauss Quadrature formula. Numerical solution of ordinary differential equations: Runge-Kutta Methods. Multiple step methods; Predictor-corrector method, Modified Euler's method, Milne-Simpson's method. Solution of Algebraic and Transcendental equations: Bisection method, Regula-Falsi method, Secant method, Newton-Raphson's method. Newton's iterative method for finding  $p^{\text{th}}$  root of a number, Order of convergence of above methods. Simultaneous linear algebraic equations: Gauss-elimination method, Gauss-Jordan method, Triangularization method (LU decomposition method), Crout's method, Cholesky Decomposition method. Iterative method, Jacobi's method, Gauss-Seidal's method, Relaxation method.

(08 Marks)

**Dynamics & Statics:** Composition and resolution of forces. Parallel forces. Moments and Couples. Analytical conditions of equilibrium of coplanar forces. Friction. Centre of Gravity. Velocity and acceleration along radial, transverse, tangential and normal directions. Relative velocity and acceleration. Simple harmonic motion. Elastic strings. Mass, Momentum and Force. Newton's laws of motion. Work, Power and Energy. Definitions of Conservative forces and Impulsive forces. Motion on smooth and rough plane curves. Projectile motion of a particle in a plane. Vector angular velocity. General motion of a rigid body. Central Orbits, Kepler laws of motion. Motion of a particle in three dimensions. Acceleration in terms of different co-ordinate system.

(08 Marks)