

# BIHAR MATHEMATICAL SOCIETY

The Syllabus has been designed in accordance with National curriculum framework CBSE, ICSE, State Board and competitive examinations. The objectives of teaching mathematics at senior school stage intend to help the students to acquire knowledge and critical understanding.

**The Syllabus of Talent Search Test in Mathematics Olympiad (TSTM) and Talent Nurture Programme (TNP) 2021 for Class VI-XII.**

## Class-VI

Number system, Factors & Multiples, Test of divisibility of numbers, HCF and LCM, Decimals and Fractions, Unitary Method, Elementary Properties of Factorial, Mensuration, Perimeter and Area, Algebraic equations and Expressions, Ratio and Proportion, Percentage and their applications, Symmetry, Making symmetry figures, Reflection and Symmetry, Geometry, Understanding Elementary Shapes of 2 and 3 dimensions, Line segment, Parallel lines, Polygons, The Triangles and its properties, Quadrilaterals, Circle, Data Handling.

## Class-VII

Elementary properties of real numbers, LCM and HCF, Divisibility rules, Fractions and Decimals, Exponents and Powers, Digit at Unit and tens place in the power of positive integers, Identities, Algebraic Equations and Expressions, Comparing Quantities, Percentage, Profit and Loss, Simple interest, Visualising of Solid Shapes, Lines and Angles, The Triangle and its Properties, Symmetry, Congruence of Triangles, Perimeter and Area, Data Handling, Simple Trigonometrically identities and their properties, Basic concept of Probability.

## Class-VIII

Properties of real numbers, Squares and Square Roots, Cubes and Cube Roots, Exponents and Powers, Comparing Quantities, Simple and Compound Interest, Discount and Partnership, Algebraic Expressions and Identities, Linear Equations in One Variable and Two Variables, Inequation, Quadrilaterals, Constructions, Mensuration, Visualising Solid Shapes, Direct and Inverse Proportions, Factorisation, Introduction to Graphs, Data Handling, Mean, Median, Mode and their Simple Properties, Basic concept of Probability. Time and Distance, Work and Time, Elementary properties of Sets.

## Class-IX

Number Systems, Prime and Composite numbers, Surds and rationalisation of surds, Congruence, Fermat and Wilson theorem, Pythagorean triads, Polynomials, Algebraic expression and identities, Linear Equations in Two Variables, Coordinate Geometry, Coordinate of a point, Distance formula, Section formula, Area of Triangle and Quadrilateral, Introduction to Euclid's Geometry, Lines and Angles, Triangles, Congruent triangle, Condition of similar triangles, Quadrilaterals, Properties of Polygons, Mensuration, Areas of Parallelograms and Triangles, Heron's Formula, Area of Cyclic quadrilateral, Surface Areas and Volumes, Circles, Constructions, Introduction of Statistics, Mean, Median of ungrouped data, Trigonometry and their Properties, Logarithm.

### Class-X

Real and Complex Numbers, Polynomials, Pair of Linear Equations in Two Variables, Quadratic Equations and Expressions, Arithmetic Progressions, Concepts of Coordinate Geometry, Straight Lines, Pair of Straight Lines, Trigonometrical Ratio, compound angles, Multiple angles and Submultiple angles, Conditional Identities, Height and distance, Geometry of triangle, Circles, Constructions, Mensuration, Areas related to Circles, Surface Areas and Volumes of Cylinder, Cone and Sphere, Introduction of Statistics, Basic concepts of Mean, Median, Mode, Histograms and Ogive, Probability of Random experiments, Sample space, Events, simple problem of single events.

### Class-XI

Sets and their properties, Subsets, Power Set, Union, Intersection, Complements of a sets, Relations and functions, Principle of Mathematical Induction, Complex Numbers, Quadratic Equations and Expressions, Partial Fraction, Binomial Theorem, Multinomial theorem, Linear Inequations, Sequences and Series (A.P, G.P and H.P), Combinatorics-Simple Permutations and Combinations, Highest power of  $n$  in  $n$  Pigeon Hole Principle (PHP), Trigonometry, Domain and range of trigonometrical functions, Graphs, Conditional Identities, Trigonometrical Equations, General solutions of trigonometrical equations, Properties Triangles, Logarithms, Coordinate Geometry of Straight Lines, Conic Sections of Circle, Parabola, Ellipse and Hyperbola, Statistics (Measure of dispersion), Mean Deviation, Variance and Standard Deviation, Limits, Continuity of a Function, Differentiation including

Chain Rules, Application of Derivatives, Probability, Addition theorem, Multiplication theorem, Conditional probability, Introduction to 3-D Geometry of Distance Formulae, Section Formulae, Direction Cosines and Ratios, Plane, Indefinite Integration.

### Class-XII

Number Theory, congruence modulo  $m$ , Inequalities, Relations and Functions, Equivalence Relations, Binary Operation, Inverse Trigonometric Functions, Matrices and Determinants, Continuity and Differentiability, Application of Derivatives, Tangent and Normal, Mean value theorem, Maxima and minima Integrals, Definite integrals, properties of definite integrals, Application of Integrals (area bounded by curve), Differential Equations of first degree and first order, order and degree, formation of differential equations, application of differential equations, Vector Algebra, Scalar and Vector products of two and three vectors, Three Dimensional Geometry of Plane and Straight Lines, shortest distance between two lines, Probability of Different type Events, Mutually Exclusive and Independent Events, Addition and Multiplication theorem, Conditional Probability, Bayes' Theorem, Random variable, Expectations, Probability Distribution and Binomial Distribution, Formation of Linear Programming Problem and their Solution by Graphical Method.

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# BIHAR MATHEMATICAL SOCIETY

Mathematics workshop  
Talent Nature Programme(TNP)

SYLLABUS

(B.Sc , M.Sc& UPSC, NET,GATE& IIT JAM)

Foundation course training for all applicants of TSTM and TNP. Second stage training for top 50 students in the merit list after the test examination of TNP.



## 1.Linear Algebra:

**Foundation Stage**-Vector spaces over  $\mathbb{R}$  and  $\mathbb{C}$ , linear dependence and independence, subspaces, bases, dimension, linear transformations, rank and nullity, matrix of a linear transformation.

Matrices, operations of matrix algebra, Kinds of matrices, Transpose adjoint and inverse of the matrix, Product of determinants, row and column reduction, echelon form, Rank and inverse of matrix, Symmetric and skew-symmetric, Hermitian and skew-Hermitian, orthogonal and unitary matrices, congruence and similarity, Solutions of consistent Systems of Linear equation by Cramer's rule.

**Second stage**-eigenvalues and eigenvectors, characteristic polynomial, Cayley-Hamilton theorem, Matrix representation of linear transformations, Jordan canonical forms, diagonal forms, inner product space, Gram-Schmidt orthonormalization process, orthonormal basis, triangular forms, Jordan forms, Quadratic forms, bilinear and quadratic forms.

## 2.Calculus:

**Foundation Stage**- functions, limits, continuity, differentiability, indeterminate forms, successive differentiation, partial derivatives, Leibnitz theorem, Total derivatives, , mean value theorem, Tangent and Normal, Curvature, Taylor's theorem with remainders, asymptotes; curvature.

Integration of rational and irrational, Function notion of integral as limit of sum, evaluation of definite integrals, reduction formulae, curve tracing, Areas of curves, Length of curves, Volumes and surface areas of solids of revolution.

**Second stage**-functions of two or three variables, maxima and minima, Lagrange's method of multipliers, Beta and Gamma functions, Jacobian, Fundamental theorem of integral calculus, double and triple integrals, Dirichlet's and Liouville's theorem, Change of order of integration, Differentiation under sign of integration and integration under sign of integration, Areas, surface area using double integral and volumes using triple integral.

### 3. Analytic Geometry:

**Foundation Stage**-Family of straight lines and circles, Standard equation of Parabola, Ellipse and Hyperbola, General equation of second degree, Transformation of rectangular axes.

Cartesian and polar coordinates in three dimensions, second degree equations in three variables, reduction to canonical forms, plane, straight lines, shortest distance between two skew lines.

**Second stage**-General equation of conics and its reduction to normal form, Equation of tangent and normal at a point of conics, equation of chord of contact, pair of tangents and director circle, Polar equation of conics and their properties.

Sphere, cone, cylinder, paraboloid, ellipsoid, hyperboloid of one and two sheets and their properties.

### 4. Ordinary Differential Equations:

**Foundation Stage**-Formulation of differential equations, equations of first order and first degree, integrating factor, Bernoulli's equations, orthogonal trajectory; equations of first order but not of first degree, Clairaut's equation, singular solution, Second and higher order linear equations with constant coefficients, complementary function, particular integral and general solution.

**Second stage**-Second order linear equations with variable coefficients, Homogeneous Equation Higher order, Variation of Parameter, Euler-Cauchy equation; Method of Laplace transformations for solving ordinary differential equations, Power series, Legendre and Bessel functions and their orthogonal properties, Frobenius method, determination of complete solution. Application to initial value problems for second order linear equations with constant coefficients, variation and parameters, Sturm-Liouville boundary value problems, Green function.

### 5. Vector Analysis and Vector Calculus:

**Foundation Stage**-Scalar and vector fields, Dot and cross product of two vectors, Scalar triple product of vectors, Vectorproduct of three and four vectors, vector identities and vector equations, Applications of vectors in mechanics.

**Second stage**-differentiation of vector field of a scalar variable, gradient, divergence and curl in cartesian and cylindrical coordinates, higher order derivatives, line integrals, surface integrals, Green, Stokes and Gauss theorems.

## 6. Theory of equations:

**Foundation Stage**- Division algorithm, greatest common divisors, polynomials, division algorithm derivative, integral, rational, real and complex roots of a polynomial relation between roots and coefficients, repeated roots, elementary symmetric function, fundamental theorem of algebra.

**Second stage**- Evaluation of symmetric functions of roots of cubic and biquadratic equations, solutions of cubic equation by Cardon's method, solution of biquadratic equations by Euler's method, Descartes rule of signs.

## 7. Hydrostatics:

**Foundation stage**-Pressure at a point, Equilibrium of fluids under given system of force. centre of pressure, Equilibrium of floating bodies.

## 8. Topology:

**Foundation Stage**-Metric spaces and their basic properties, open sphere, open set, neighborhoods, closed set, Accumulation point, closure and interior, convergence of sequence in a metric space and their properties, Cauchy sequence and complete metric space, continuous mappings, Compactness and their basic properties , Normed linear space.

**Second stage**- Definition and examples of topological space, closed set, closure, Dense subset, Derived set, Bases and sub-spaces, Continuity of functions and homeomorphism, separation axiom  $T_0$ ,  $T_1$ ,  $T_2$  spaces their characteristics and basic properties, connectedness.

## 9. Probability :

**Foundation stage**-Event, Probability of an event, sample space, probabilities a finite sample space, Mutually exclusively events and complementary events,

independent events, conditional probability, multiplication theorem, theorem of total probability, Bayes theorem and independents of events.

**Second Stage**-Random variables and their probability functions. Mathematical expectation and moment of a random variable, Mean absolute deviation, variance, standard variation, Chebyshev's theorems for a probability distribution and frequency distribution of measurements.



## 1. Algebra :

**Foundation Stage**- Binary Operation, Notions of group, Abelian group with examples, Groups, subgroups, cyclic groups, cosets, Lagrange's Theorem, normal subgroups, quotient groups, homomorphism of groups, Automorphism, basic isomorphism theorems, Centre, Normalizer, Conjugacy, class equation, Commutator and commutator sub group

Rings, Integral domains, subrings and ideals, homomorphisms of rings; integral domain, Division ring, Polynomial ring, field and their examples.

**Second stage**-Permutation groups, Cayley's theorem, Sylow theorems, homomorphisms of rings, integral domains, quotient rings, Imbedding of a ring and integral domain in a field, characteristics of a field, polynomials over commutative ring, unique factorization domain, principal ideal domains, Euclidean domain, polynomial rings, finite fields, field extension, Galois theorem.

## 2. Real Analysis :

**Foundation Stage**-Real number system as an ordered field with least upper bound property, Dedekind's theory of real numbers, Cantor's construction of real numbers, properties of real numbers sequences, limit of a sequence, Cauchy sequence, completeness of real line, Monotonic function, Continuity and uniform continuity of functions, properties of continuous functions on compact sets.

Infinite series and their convergence, Comparison test, cauchy root test, Raabe's test, cauchy condensation test, Integral test, Leibnitz's test, Gauss Test, kummer's test, de morgan and bertrand's test, absolute convergence and rearrangement of series, pringsheim's theorem, cauchy's multiplication of series and its convergence.



**Second stage**-Riemann sum and Riemann integral, Improper integral, convergence of an improper integral, comparison tests, fundamental theorems of integral calculus. Uniform convergence of sequence and series of functions, Weierstrass M-test, uniform convergence and continuity, Dini's test, Abel's test, Dirichlet's Test, Uniform convergence and integration, Uniform convergence and differentiation, continuity, differentiability and integrability for sequences and series of functions; Inverse and Implicit theorems, maxima and minima, Ascoli-Arzelà theorem, Contraction mapping principle, Weierstrass sequence and series of functions and their pointwise convergence.

### 3. Complex Analysis :

**Foundation Stage**-Algebra of complex numbers, Continuity, Differentiability, Analytic functions, Cauchy-Riemann equations, Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Morera's theorem, Taylor's series, Laurent's series.

**Second stage**-Calculus of residue, singularities; Isolated singularity, meromorphic function, Argument Principle, Schwartz lemma, open mapping theorem, Cauchy's residue theorem; Rouché's theorem, fundamental theorem of algebra, contour integration, power series representation of an analytic function, Möbius transformation, Conformal mappings.

### 4. Operation Research :

**Foundation Stage**-Linear programming problems, basic solution, basic feasible solution and optimal solution; graphical method, convex set, simplex method of solutions.

**Second stage**-Revised simplex method, infeasible and unbounded linear programming problem, Big-M Method, Two phase method, duality, transportation, assignment problems, Game theory, sequencing, replacement model, Queuing theory.

### 5. Partial differential equations :

**Foundation stage**-Family of surfaces in three dimensions and formulation of partial differential equations, solution of quasi-linear partial differential equations of the first order.

**Second stage**- Linear partial differential equations of the second order with constant coefficients, Lagrange's and Charpit's methods for solving first order solving PDEs, Cauchy's problem for first order PDEs, Monge's Method, Method of separation of variables for Laplace, Heat and wave equations,.

### 6. Numerical Analysis :



**Foundation Stage**-Finite differences,Newton's (forward and backward) interpolation, Lagrange's interpolation, Hermite and spline interpolation,Numerical methods: solution of algebraic and transcendental equations of one variable by bisection, Regula-Falsi and Newton-Raphson methods.

**Second stage**-Solution of system of linear equations by Gaussian elimination and Gauss-Jordan (direct), Gauss-Seidel (iterative), Relaxation Method, Numerical integration, Trapezoidal rule, Simpson's rules, Gaussian quadrature formula. Numerical solution of ordinary differential equations: Euler, Modified Euler and Runge Kutta-methods, Picard's method .

### 7. Fluid Dynamics :

**Second stage**- Equation of continuity, Euler's equation of motion for inviscid flow, Stream-lines, path of a particle, Potential flow, Two-dimensional and axisymmetric motion, Sources and sinks, vortex motion,Navier-Stokes equation for a viscous fluid.

### 8. Functional Analysis :

**Foundation Stage**- complex linear space, normed linear space, completion of a normed linear space, Banach space and their definition, properties and examples,

**Second stage**-Inner product space and Hilbert space and their properties and examples, Orthonormal bases, projection theorem, Riesz representation theorem, spectral theorems for selfadjoint operators, Cauchy Schwartz inequality, parallelogram law and polarization identity, Hahn-Banach theorem on real linear space, Open mapping and closed graph theorems, Principle of uniform boundness.

### 9. Statistics :

Mean,Variance and standard deviation of random variables,Binomial,Poisson and Normal distributions,Correlation and linear regressions.

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