

# SYLLABUS FOR THE BATCH FROM YEAR 2022 TO YEAR 2025

## **B.A. / B.Sc.** (12+3 SYSTEM OF EDUCATION) **Mathematics**

**Examinations: 2022–25**



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## **GURU NANAK DEV UNIVERSITY AMRITSAR**

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B.A./B.Sc. (Semester System) (12+3 System of Education) (Batch 2022-25)  
(Faculty of Sciences)

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**SEMESTER-I****MATHEMATICS****PAPER-I: ALGEBRA****Time: 3 Hours****Marks: 50****Instructions for the Paper Setters:-**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Linear independence of row and column vectors. Row rank, Column rank of a matrix, Equivalence of column and row ranks, Nullity of matrix, Applications of matrices to a system of linear (both homogeneous and non-homogeneous) equations. Theorems on consistency of a system of linear equations.

**SECTION-B**

Eigen values, Eigen vectors, minimal and the characteristic equation of a matrix. Cayley Hamilton theorem and its use in finding inverse of a matrix. Quadratic Forms, quadratic form as a product of matrices. The set of quadratic forms over a field.

**SECTION-C**

Congruence of quadratic forms and matrices. Congruent transformations of matrices. Elementary congruent transformations. Congruent reduction of a symmetric matrix. Matrix Congruence of skew-symmetric matrices. Reduction in the real field. Classification of real quadratic forms in  $n$  variables. Definite, semi-definite and indefinite real quadratic forms. Characteristic properties of definite, semi-definite and indefinite forms.

**SECTION-D**

Relations between the roots and coefficients of general polynomial equation in one variable. Transformation of equations and symmetric function of roots, Descarte's rule of signs, Newton's Method of divisors, Solution of cubic equations by Cardan method, Solution of biquadratic equations by Descarte's and Ferrari's Methods.

**Books Recommended:-**

1. K.B. Dutta: Matrix and Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi (2002).
2. H.S. Hall and S.R. Knight: Higher Algebra, H.M. Publications, 1994.
3. Chandrika Parsad: Text book on Algebra and Theory of Equations, Pothishala Pvt. Ltd., Allahabad.
4. S.L. Loney: Plane Trigonometry Part-II, Macmillan and Company, London.
5. Shanti Narayan and P.K. Mittal: Text Book of Matrices.

**SEMESTER-I****MATHEMATICS****PAPER-II: CALCULUS AND TRIGONOMETRY****Time: 3 Hours****Marks: 50****Instructions for the Paper Setters:-**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Real number system and its properties, lub, glb of sets of real numbers, limit of a function, Basic properties of limits, Continuous functions and classification of discontinuities, Uniform continuity.

**SECTION-B**

Differentiation of hyperbolic functions, Successive differentiation, Leibnitz theorem, Taylor's and Maclaurin's theorem with various forms of remainders, Indeterminate forms.

**SECTION-C**

De-Moivre's Theorem and its applications, circular and hyperbolic functions and their inverses.

**SECTION-D**

Exponential and Logarithmic function of a complex variable, Expansion of trigonometric functions, Gregory's series, Summation of series.

**Books Recommended:-**

1. N. Piskunov: Differential and Integral Calculus, Peace Publishers, Moscow.
2. Gorakh Prasad: Differential Calculus, Pothishala Pvt. Ltd., Allahabad.
3. Erwin Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons, 1999.

**SEMESTER-II****MATHEMATICS****PAPER-I: CALCULUS AND DIFFERENTIAL EQUATIONS****Time: 3 Hours****Marks: 50****Instructions for the Paper Setters:-**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Asymptotes, Tests for concavity and convexity, Points of inflexion, Multiple Points, Curvature, Tracing of Curves (Cartesian and Parametric coordinates only).

**SECTION-B**

Integration of hyperbolic functions. Reduction formulae. Definite integrals. Fundamental theorem of integral calculus. Quadrature, rectification.

**SECTION-C**

Exact differential equations. First order and higher degree equations solvable for  $x, y, p$ . Clairaut's form and singular solutions. Geometrical meaning of a differential equation. Orthogonal trajectories.

**SECTION-D**

Linear differential equations with constant and variable coefficients. Variation of Parameters method, reduction method, series solutions of differential equations. Power series method, Bessel and Legendre equations (only series solution).

**Books Recommended:-**

1. D.A. Murray: Introductory Course in Differential Equations. Orient Longman (India), 1967.
2. G.F. Simmons: Differential Equations, Tata McGraw Hill, 1972.
3. E.A. Codrington: An Introduction to Ordinary Differential Equations, Prentice Hall of India, 1961.
4. Gorakh Prasad: Integral Calculus, Pothishala Pvt. Ltd., Allahabad.
5. Erwin Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons, 1999. 52

**SEMESTER-II****MATHEMATICS****PAPER-II: CALCULUS****Time: 3 Hours****Marks: 50****Instructions for the Paper Setters:-**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Limit and Continuity of functions of two variables, Partial differentiation, Change of variables, Partial derivatives and differentiability of real-valued functions of two variables, Schwartz's and Young's Theorem, Statements of Inverse and implicit function theorems and applications.

**SECTION-B**

Euler's theorem on homogeneous functions, Taylor's theorem for functions of two variables, Jacobians, Envelopes. Evolutes, Maxima, Minima and saddle points of functions of two variables.

**SECTION-C**

Lagrange's undetermined multiplier method, Double and Triple Integrals, Change of variables, Applications to evaluation of areas, Volumes, Surfaces of solid of revolution, Change of order of integration in double integrals.

**SECTION-D**

Application to evaluation of area, volume, surface of solids of revolutions.

**Books Recommended:-**

1. Narayan, S. and P.K. Mittal: Integral Calculus. Sultan Chand & Sons.
2. Kreyszig, E.: Advanced Engineering Mathematics.
3. Narayan S. and P.K. Mittal: Differential Calculus, Sultan Chand & Sons.

**SEMESTER-III****MATHEMATICS****PAPER-I: ANALYSIS****Time: 3 Hours****Marks: 50****Instructions for the Paper Setters:-**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Definition of a sequence. Theorems on limits of sequences. Bounded and monotonic sequences. Cauchy's convergence criterion.

**SECTION-B**

Series of non-negative terms. Comparison tests. Cauchy's integral test. Ratio test. Cauchy's root test. Logarithmic test. Cauchy condensation test, Gauss test, Alternating series. Leibnitz's test. Absolute and conditional convergence.

**SECTION-C**

Partitions, Upper and lower sums. Upper and lower integrals, Riemann integrability. Conditions of existence of Riemann integrability of continuous functions and of monotone functions. Algebra of integrable functions.

**SECTION-D**

Improper integrals and statements of their conditions of existence. Test of the convergence of improper integral, Beta and Gamma functions.

**Books Recommended:**

1. Malik, S.C. and Savita Arora: Mathematical Analysis, Wiley Eastern Ltd. (1991).
2. Apostol, T.M.: Mathematical Analysis, Addison Wesley Series in Mathematics (1974).
3. Narayan, S. and P.K. Mittal: Integral Calculus, Sultan Chand & Sons.

**SEMESTER-III****MATHEMATICS****PAPER-II: ANALYTICAL GEOMETRY****Time: 3 Hours****Marks: 50****Instructions for the Paper Setters:-**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Transformation of axes, shifting of origin, Rotation of axes in two dimension and three dimension, The invariants, Joint equation of pair of straight lines, equations of bisectors

**SECTION-B**

Parabola and its properties. Tangents and normals, Pole and polar, pair of tangents at a point, Chord of contact, equation of the chord in terms of mid point and diameter of conic.

**SECTION-C**

Ellipse and hyperbola with their properties, Tangents and normals, Pole and polar, pair of tangents at a point, Chord of contact, Identifications of curves represented by second degree equation (including pair of lines).

**SECTION-D**

Intersection of three planes, condition for three planes to intersect in a point or along a line or to form a prism, Sphere: Section of a sphere by a plane, spheres of a given circle. Intersection of a line and a sphere. Tangent line, tangent plane, power of a point w.r.t. a sphere, radical planes.

**Books Recommended**

1. Gorakh Prasad and H.C. Gupta: Text Book on Coordinate Geometry.
2. S.L. Loney: The Elements of Coordinate Geometry, Macmillan and Company, London.
3. Narayan, S.: Analytical Solid Geometry, Sultan Chand & Sons (2005).
4. Kreyszig, E.: Advanced Engineering Mathematics.
5. Thomos, G.B. and Finney, R.L.: Calculus and Analytic Geometry.



**SEMESTER-IV**

**MATHEMATICS**

**PAPER-I: STATICS AND VECTOR CALCULUS**

**Time: 3 Hours**

**Marks: 50**

**Instructions for the Paper Setters:-**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Composition and resolution of forces (parallelogram law, triangle law, polygon law, Lami's Theorem, ( $-\mu$ ) theorem, Resultant of a number of coplanar forces, parallel forces. Moments, Varignon's theorem of moments, Couples, Resultant of two Coplanar Couples, Equilibrium of two coplanar couples, Resultant of a force and a couple. Equilibrium of coplanar forces.

**SECTION-B**

Friction, Laws of friction, Equilibrium of a particle on a rough plane. Centre of Gravity: Centre of gravity of a rod, triangular lamina, solid hemisphere, hollow hemisphere, solid cone and hollow cone.

**SECTION-C**

Vector differentiation, Gradient, divergence and curl operators, line integrals, Vector identity, Vector integration.

**SECTION-D**

Theorems of Gauss, Green, Stokes and problems based on these.

**Books Recommended:**

1. S.L. Loney: Statics, Macmillan and Company, London.
2. R.S. Verma: A Text Book on Statics, Optical Pvt. Ltd., Allahabad.
3. Spiegel, M.R.: Introduction to Vector Calculus and Tensor.
4. Spiegel, M.R.: Vector Analysis.

**SEMESTER-IV****MATHEMATICS****PAPER-II: SOLID GEOMETRY****Time: 3 Hours****Marks: 50****Instructions for the Paper Setters:-**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Cylinder as surface generated by a line moving parallel to a fixed line and through fixed curve. Different kinds of cylinders such as right circular, elliptic, hyperbolic and parabolic in standard forms

**SECTION-B**

Cone with a vertex at the origin as the graph of homogeneous equation of second degree in  $x$ ,  $y$ ,  $z$ . Cone as a surface generated by a line passing through a fixed curve and fixed point outside the plane of the curve, right circular and elliptic cones.

**SECTION-C**

Equation of surface of revolution obtained by rotating the curve  $f(x, y) = 0$  about the  $z$ -axis in the form of  $f(x^2 + y^2, z) = 0$ . Equation of ellipsoid, hyperboloid and paraboloid in standard forms.

**SECTION-D**

Surfaces represented by general equation of  $2^{\text{nd}}$  degree  $S = 0$ . Tangent lines, tangent planes and Normal plane.

**Books Recommended:**

1. Narayan, S.: Analytical Solid Geometry, Sultan Chand & Sons (2005).
2. Kreyszig, E.: Advanced Engineering Mathematics.

**SEMESTER-V**  
**MATHEMATICS**  
**PAPER-I: DYNAMICS**

**Time: 3 Hours**

**Marks: 50**

**Instructions for the Paper Setters:-**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Rectilinear motion in a straight line with uniform acceleration, Newton's laws of motion, Motion of two particles connected by a string.

**SECTION-B**

Motion along a smooth inclined plane, Variable acceleration, Simple Harmonic Motion.

**SECTION-C**

Curvilinear motion of particle in a plane, Definition of velocity and acceleration, projectiles, Oscillations: Free Vibrations, Simple Pendulum, Conical Pendulum.

**SECTION-D**

Work, Power and Energy: Kinetic and Potential energy, Conservative forces. Theorem of conservation of energy. Work done against gravity.

**Books Recommended:**

1. S.R.Gupta: A text book of Dynamics
2. F. Chorlton: Dynamics.
3. S.L. Loney: An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies, Cambridge University Press, 1956.

**SEMESTER-V****MATHEMATICS****PAPER-II: NUMBER THEORY****Time: 3 Hours****Marks: 50****Instructions for the Paper Setters:-**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Preliminaries: Proof by induction, Binomial Theorem. Divisibility in Integers: Basic Definitions and Properties, The division Algorithm, GCD, The Euclidean Algorithm, LCM, Existence and determination of solution to the linear Diophantine equation  $ax + by = c$ , primes-definition & Properties, the fundamental theorem of Airthmetic.

**SECTION-B**

Number-theoretic functions: the greatest integer function, Euler's Phi-function, Sum & number of divisors functions, *möbius* function & the Inversion formula.

**SECTION-C**

Congruences-definition and properties, linear congruences, existence & solution of the linear congruence,  $ax \equiv b(\text{mod } m)$ , Complete and reduces residue systems, Chinese remainder theorem.

**SECTION-D**

Fermat's theorem, Euler's theorem, Pseudoprimes Wilson's theorem. Application to Cryptography-Factorization methods due to Fermat, RSA.

**Books Recommended:**

1. David M. Burton: Elementary Number Theory, Seventh Edition, McGraw-Hill, Indian Reprint, 2012.
2. Ivan Niven, Herbert S, Zuckerman & Hugh L. Montgomery : An Introduction to the theory of Numbers, Wiley, fifth edition, 1991.
3. Tom M. Apostol, An introduction to Analytical Number Theory, Springer-Verlag, UTM.

**SEMESTER–VI****MATHEMATICS****PAPER–I: LINEAR ALGEBRA****Time: 3 Hours****Marks: 50****Instructions for the Paper Setters:-**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION–A**

Definition of groups, rings and fields with examples. Definition of a vector space, subspaces with examples. Direct sum of subspaces. Linear span, Linear dependence, Linear independence of vectors. Linear combination of vectors.

**SECTION–B**

Basis of a vector space, Finitely generated vector spaces. Existence theorem for basis. Invariance of the number of elements of the basis set. Dimension of sum of two subspaces. Quotient space and its dimension.

**SECTION–C**

Linear transformation. Algebra of linear transformation. Rank- Nullity theorem, Isomorphism and Isomorphic spaces.

**SECTION–D**

Matrix of a linear transformation. Changes of basis, Linear operator.

**Books Recommended:**

1. K.Hoffman & R. Kunze: Linear Algebra, 2nd Edition, Prentice Hall, New Jersey, 1971.
2. V. Krishnamurthy, V. P. Mainra and J.L. Arora: An Introduction to Linear Algebra, East West Press, 1976.
3. Shanti Narayan & P.K. Mittal: A Text Book of Matrices, 10th Edition (2002), S.Chand & Co.
4. Surjit Singh: Linear Algebra, 1997.

**SEMESTER-VI****MATHEMATICS****PAPER-II: NUMERICAL ANALYSIS****Time: 3 Hours****Marks: 50****Instructions for the Paper Setters:-**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Error generation, propagation, error estimation and error bounds, Solution of non-linear equations, Bisection method, Iteration method, Newton's Method, Generalized Newton's Method, Method of false position, Muller's method, Rate of convergence of these methods.

Solution of linear system of equation; Direct method, Gauss elimination variant (Gauss Jordan and Crout reduction), Triangular Method, Iterative Method, Jacobi's Method, Gauss Seidel Method.

**SECTION-B**

Finite Differences: Forward, Backward, Central, Divided differences, shift operator, relationship between the operators and detection of errors by use of difference operator.

**SECTION-C**

Interpolation with divided difference, Newton's formula, Lagrangian Method, Finite difference interpolation, Gauss formula, Stirling formula, Bessel's formula, Error Estimation, Extrapolation. Numerical differentiation, Method based on interpolation. Numerical Integration, Trapezoidal rule, Simpson's rule, Weddle rule, Romberg Integration.

**SECTION-D**

Gaussian integration method, Gaussian legendre integration. Double numerical integration. Numerical solution of ordinary differential equations, Initial value problem, Taylor's method, Euler's methods, Picard's method, Milne's Method, Runge-Kutta Method. Predictor- Corrector's Method.

**Books Recommended:**

1. S.S. Sastry: Introductory Methods of Numerical Analysis, 2003 (3rd Edition), Prentice Hall of India.
2. A. Maritava Gupta and Subash Ch. Bose: Introduction to Numerical Analysis.