

# **ORDINANCE, REGULATION & SYLLABUS**

**For**

## **B.Sc. [MATHEMATICS]**



***Offered by***

**NEHRU GRAM BHARATI**

**(DEEMED TO BE UNIVERSITY),**

**KOTWA-JAMUNIPUR-DUBAWAL**

**PRAYAGRAJ-221505**

**UTTAR PRADESH**

**Session:**

**From 2019 – 2020**

**Syllabus B. Sc. (Semester System)**  
**Subject: mathematics**

**Semester-I**

S. No.	Code	Papers	Title	IA	ESE	Total Marks	Credit
1.	BOM-101	I	Algebra	10	40	50	2
2.	BOM-102	II	Calculus	10	40	50	2
3.	BOM-103	III	Analytical Geometry	10	40	50	2
4.		Viva		10	40	50	2
<b>Total Credits</b>						<b>200</b>	<b>8</b>

**Semester-II**

S. No.	Code	Papers	Title	IA	ESE	Total Marks	Credit
1.	BOM-201	I	Algebra	10	40	50	2
2.	BOM-202	II	Calculus	10	40	50	2
3.	BOM-203	III	Analytical Geometry	10	40	50	2
4.	BOM-204	Viva		10	40	50	2
<b>Total Credits</b>						<b>200</b>	<b>8</b>

**Semester-III**

S. No.	Code	Papers	Title	IA	ESE	Total Marks	Credit
1.	BOM-301	I	Linear Algebra	10	40	50	2
2.	BOM-302	II	Differential Equations	10	40	50	2
3.	BOM-303	III	Mechanics	10	40	50	2
4.	BOM-304	Viva		10	40	50	2
<b>Total Credits</b>						<b>200</b>	<b>8</b>

**Semester-IV**

S. No.	Code	Papers	Title	IA	ESE	Total Marks	Credit
1.	BOM-401	I	Linear Algebra	10	40	50	2
2.	BOM-402	II	Differential Equations	10	40	50	2
3.	BOM-403	III	Mechanics	10	40	50	2
4.	BOM-404	Viva		10	40	50	2
<b>Total Credits</b>						<b>200</b>	<b>8</b>

**Semester-V**

<b>S. No.</b>	<b>Code</b>	<b>Papers</b>	<b>Title</b>	<b>IA</b>	<b>ESE</b>	<b>Total Marks</b>	<b>Credit</b>
1.	BOM-501	I	Analysis	10	40	50	2
2.	BOM-502	II	Numerical Methods	10	40	50	2
3.	BOM-503	III	Complex Analysis	10	40	50	2
4.	BOM-504/BOM-505/BOM-506	IV	Fluid Mechanics I/Operations Research I/Discrete Mathematics	10	40	50	2
5.	BOM-507	Viva		20	80	100	4
				<b>Total Credits</b>		<b>300</b>	<b>12</b>

**Semester-VI**

<b>S. No.</b>	<b>Code</b>	<b>Papers</b>	<b>Title</b>	<b>IA</b>	<b>ESE</b>	<b>Total Marks</b>	<b>Credit</b>
1.	BOM-601	I	Analysis	10	40	50	2
2.	BOM-602	II	Numerical Methods	10	40	50	2
3.	BOM-603	III	Tensor Calculus	10	40	50	2
4.	BOM-604/BOM-605/BOM-606	IV	Fluid Mechanics II/Operations Research II/Discrete Mathematics	10	40	50	2
5.	BOM-607	Viva		20	80	100	4
				<b>Total Credits</b>		<b>300</b>	<b>12</b>

**Semester-I**  
**Paper-I**

**BOM-101: Algebra**

**Unit-I:** Sets and Relations, Order Relation, Equivalence Relations, functions (maps), injective and surjective functions, Direct and inverse images of subsets under functions, Binary Operation on a set.

**Unit-II:** Number system, Natural number, Integers, Division Process in  $\mathbb{Z}$ , Division Algorithm, Euclidean Algorithm, Fundamental theorem of arithmetic, Fermat's and Wilson's Theorems.

**Unit-III:** Congruence's and residue classes, Rational Numbers, Real Numbers, Axioms of Real Numbers, Archimedean Property, Density Property.

**Unit-IV:** Complex Numbers, Relations between the roots and coefficients of a general polynomial equation in one variable, Transformation of equations, Descartes' rule of signs.

**Unit-V:** Solution of Cubic equations (Cardan's Method), Solution of biquadratic equations.

**References: (Books Recommended)**

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra, 3rd Edition, Cambridge University press, 2000.
2. Artin, Algebra, Prentice Hall of India.
3. Ramji Lal, Algebra (Vol.I), Shail Publication, Allahabad.
4. R. S. Mishra and N.N. Bhattacharya, Fundamental Structures in Modern Algebra, Pothishala Pvt. Ltd. Allahabad.

**Paper-II**

**BOM-102: Calculus**

**Unit-I:** Functions of one variable, Limit and Continuity, Properties of Continuous Functions, Local boundedness and local preservation of sign.

**Unit-II:** Boundedness and intermediate value properties of continuous functions over closed intervals, Differentiability, Algebra of differentiable functions.

**Unit-III:** Interior extremum Theorem, Rolle's theorem, Lagrange's and Cauchy's mean-value theorems, Indeterminate forms.

**Unit-IV:** Successive differentiation, Leibnitz theorem, Maclaurin and Taylor series expansions, Tangents and normals, Asymptotes.

**Unit-V:** Local maximum and minimum points, Critical points for absolute maximum and minimum over closed intervals, Curvature, tracing of curves in Cartesian and polar coordinates.

**Reference: (Books Recommended)**

1. N.N. Bhattacharya, A First course in Real Analysis, Ram Narain Lal & Co., Allahabad.
2. Gorakh Prasad, Differential Calculus, Pothishala Private Ltd. Allahabad.
3. Gorakh Prasad, Integral Calculus, Pothishala Private Ltd., Allahabad.

4. VyasJiDwivedi, Introduction to real Analysis, PrayagPustakBhawan, Allahabad.
5. Robert G. Bartle & Donald R. Sherbert, Introduction to Real Analysis, Wiley & Sons, Inc., New York.

### **Paper-III**

#### **BOM-103: Analytical geometry**

**Unit-I:** Polar Coordinates, Distance between two given points, Polar equations of straight lines and circles.

**Unit-II:** Polar equation of a conic, directrix, tangents and normal, Polar of a point with respect to a conic, Asymptotes.

**Unit-III:** Orthogonal Cartesian coordinates of a point on space, Projections and direction cosines, Equation of plane in different forms, Plane bisecting angles between two given planes.

**Unit-IV:** Pairs of planes, Symmetrical and non-symmetrical forms of a straight line, shortest distance between two skew lines, coplanar lines.

**Unit-V:** Equation of a sphere, plane section of a sphere and intersection of two spheres, spheres passing through a circle, tangent plane.

#### **Reference: (Books Recommended)**

1. P. N. Pandey, Polar Coordinate Geometry, Sharda Academic Publishing House, Allahabad.
2. Mata AmbarTiwari&R. S. Sengar, A Course in Vector Analysis with Applications.
3. N. Saran and R. S. Gupta, Analytical Geometry of Three Dimensions, Pothishala Pvt. Ltd.
4. Robert J.T. Bell, An Elementary Treatise on Coordinate Geometry of Three Dimensions, Classic Reprint Series.
5. P. R. Vittal, Analytical Geometry of Two & Three Dimensions, Pearson.

### **Semester-II**

#### **Paper - I**

#### **BOM-201: Algebra**

**Unit-I:** Definition of a Group with examples and simple properties, Subgroups, Cyclic groups, Coset decomposition, Lagrange's Theorem, and its consequences, Fermat's and Euler's theorems

**Unit-II:** Homomorphism and isomorphism, Properties and examples, Normal subgroups, quotient groups, the fundamental theorems of Homomorphism.

**Unit-III:** Permutation Groups, cycle decomposition, Even and odd permutations, the alternative group  $A_n$ , Cayley's theorem.

**Unit-IV:** Rings, Subrings, Ideals and quotient rings, Ring homomorphism, Integral domains and fields, Field of quotient of an Integral domain.

**Unit-V:** Polynomial Rings over a Field, Division and Euclidean algorithms for Polynomials, Remainder & Factor Theorems.

**References: (Books Recommended)**

1. RamjiLal, Algebra (Vol.I), Shail Publication, Allahabad.
2. RamjiLal, Algebra (Vol. II), Shail Publication, Allahabad.
2. Dummit Foote, Abstract Algebra, Wiley & Sons, Inc., New York.
4. R. S. Mishra and N.N. Bhattacharya, Fundamental Structures in Modern Algebra, Pothishala Pvt. Ltd. Allahabad.
5. Joseph A. Gallian, Contemporary Abstract Algebra, Narosa Publishing House.

**Paper-II**

**BOM-202: Calculus**

**Unit-I:** Functions of several variables, limits and continuity, Partial and total differentiation.

**Unit-II:** Change of variables, Jacobian determinant, Homogeneous function and polynomial Euler's theorem on homogeneous functions.

**Unit-III:** Integration of irrational algebraic functions and transcendental functions, Reduction formulae.

**Unit-IV:** Definite integrals, Elementary ideas of improper integrals, Beta and Gamma functions.

**Unit-V:** Quadrature, Rectification, volumes and surfaces of solids of revolution, Double and triple integrals. Change of order of integration in double integrals.

**References: (Books Recommended)**

1. Robert G. Bartle & Donald R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, Inc., New York.
2. S. C. Malik & Savita Arora, Mathematical Analysis, New Age International Publishers.
3. T. M. Apostol, Calculus (Vol. I), John Wiley & Sons, Inc., New York.
4. T. M. Apostol, Mathematical Analysis, John Wiley & Sons, Inc., New York.

**Paper -II**

**BOM-203: Analytical Geometry**

**Unit-I:** Plane of contact polar lines, angle of intersection of two spheres, power of a point, radical plane, line and center, co-axial system of spheres.

**Unit-II:** Cone and cylinders with a given base, Intersection of a cone and a plane passing through the vertex of the cone, Tangent lines and planes.

**Unit-III:** Reciprocal cones, right circular cones and cylinders, Central Conicoids, Tangent Lines & planes.

**Unit-IV:** Director sphere, polar planes and polar lines of conicoids, enveloping cones and cylinders of central conicoids.

**Unit-V:** Section of conicoids with a given centre, diametral planes, normals, conjugate diameters of an ellipsoid.

**Reference: (Books Recommended)**

1. N. Saran and R. S. Gupta, Analytical Geometry of Three Dimensions, Pothishala Pvt. Ltd.
2. Robert J.T. Bell, An Elementary Treatise on Coordinate Geometry of Three Dimensions, Classic Reprint Series.
3. P. R. Vittal, Analytical Geometry of Two & Three Dimensions, Pearson.

**Semester-III**

**Paper -I**

**BOM-301: Linear Algebra**

**Unit-I:** Vector Spaces, Definition, Properties and examples, Linear combination of vectors, linear sum and direct sum of subspaces.

**Unit-II:** Linear span of subsets, linear independence of subsets, Definition of a basis, Invariance of basis number, Dimension, Dimension of linear sum of subspaces, Quotient spaces, Dimension of quotient space.

**Unit-III:** Linear Transformations, Definition, Properties and examples, Algebra of linear transformations.

**Unit-IV:** Non singular linear maps, Fundamental theorems of vector space homomorphism, First and second Isomorphism Theorem.

**Unit-V:** Rank of a linear transformation, Rank-nullity Theorem, Equivalence of one-one and onto linear transformation from  $V$  to  $V$ , Dual space and dual bases, Transpose of a linear transformation.

**Reference: (Books Recommended)**

1. RamjiLal, Algebra (Vol. II), Shail Publication, Allahabad.
2. R. S. Mishra, Linear Algebra, Ram NarainLal & Co.
3. Kenneth Hoffman & Ray Kunze, Linear Algebra, PHI.
4. M. Artin, Algebra, Pearson.
5. P. B. Bhattacharya, First Course in Linear Algebra, New Age International Publisher.

**Paper-II**

**BOM-302: Differential Equations**

**Unit-I:** Ordinary Differential Equations, Degree and order of a differential equation. Differential equations of first order and first degree. Differential equations in which the variables are separable, Equation with homogeneous coefficient.

**Unit-II:** Linear equations and equations reducible to the linear form, Exact differential equations, Integrating factors

**Unit-III:** First order higher degree equations, Equations solvable for x, y and p, Clairaut's form and Singular solutions, orthogonal trajectories.

**Unit-IV:** Linear differential equations with constant coefficients. Homogeneous linear differential equations and their solutions, Linear independence of solutions, Wronskian of solutions functions and its relationship with linear independence.

**Unit-V:** Non-homogeneous linear differential equations, Method of undetermined coefficients.

**Reference: (Books Recommended)**

1. R. S. Sengar, Ordinary Differential Equations with Integration, PrayagPustakBhawan, Allahabad.
2. B. Rai. & D.P. Choudhury, Ordinary Differential Equations an Introduction, Narosa Publishing House.
3. B. Rai, D. P. Choudhury& H. I. Freedman, A Course in Ordinary Differential Equations,
4. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand.
5. Shepley L. Ross, Differential Equations, John Wiley & Sons, Inc., New York.

**: Paper-III**

**BOM-303 Mechanics**

**Unit-I:** Moment of a force, Couple of Forces, Analytical conditions of equilibrium of coplanar forces, **Unit-II:** Concept of Virtual work, Principle of virtual work & its applications.

**Unit-III:** Common Catenary, intrinsic equation of common Catenary, Cartesian equation.

**Unit-IV:** Stable and Unstable equilibrium.

**Unit-V:** Forces in three dimensions, Line coordinates of a line, Central axis and Wrench, Null line and null plane.

**Reference: (Books Recommended)**

1. Mata AmbarTiwari& R. S. Sengar, A Course in Vector Analysis with Applications.
2. R. S. Varma, Text Book on Statics, Pothishala Private Limited.
3. S. L. Loney, Elementary Treatise on Statics.

**Semester-IV**

**Paper-I**

**BOM-401: Linear Algebra**

**Unit-I:** Matrices, Matrix representation of a linear transformation. Change of base and its effect on matrix representation.

**Unit-II:** Elementary operations on matrices, Equivalent and similar matrices, Trace of a square matrix and of a linear transformation, Definition and properties of a determinant of a square matrix.

**Unit-III:** Rank of Matrices, Rank- Nullity Theorems, Row and Column rank, Determinantal rank, Equivalence of notions of all the four types of rank.

**Unit-IV:** Applications of Matrices to a system of Linear (Both homogeneous and non-homogeneous) equations, theorems on consistency of a system of linear equations.

**Unit-V:** The characteristic equation of a matrix, Eigenvalues and eigenvectors, Cayley-Hamilton Theorem and its use in finding inverse of a matrix, Diagonalisation of square matrices having distinct Eigenvalues.

**Reference: (Books Recommended)**

1. RamjiLal, Algebra (Vol. II), Shail Publication, Allahabad.
2. R. S. Mishra, Linear Algebra, Ram NarainLal& Co.
3. Kenneth Hoffman& Ray Kunze, Linear Algebra, PHI.
4. M. Artin, Algebra, Pearson.
5. P. B. Bhattacharya, First Course in Linear Algebra, New Age International Publisher.

**Paper-II**

**BOM-402: Differential Equations**

**Unit-I:** Solving linear differential equations of second order with variable coefficients by changing the dependent/independent variable, finding particular solution by the method of variation of parameters.

**Unit-II:** Linear differential equations of arbitrary orders and their solutions, Euler Cauchy equations.

**Unit-III:** Inverse operator method for particular solutions of non-homogeneous equations, Coupled linear differential equations of first order with constant coefficients.

**Unit-IV:** Linearity of Laplace transform, Existence theorem for Laplace transforms Laplace transforms of derivatives and Integrals, Shifting Theorems.

**Unit-V:** Differentiation and integrations of transforms, Inverse Laplace transform, solution of differential equations using the Laplace transform.

**Reference: (Books Recommended)**

1. R. S. Sengar, Ordinary Differential Equations with Integration, PrayagPustakBhawan, Allahabad.
2. B. Rai. & D.P. Choudhury, Ordinary Differential Equations an Introduction, Narosa Publishing House.
3. B. Rai, D. P. Choudhury& H. I. Freedman, A Course in Ordinary Differential Equations,
4. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand.
5. Shepley L. Ross, Differential Equations, John Wiley & Sons, Inc., New York.

**Paper-III**

**BOM-403: Mechanics**

**Unit-I:** Concept of velocity, Acceleration, Velocities and accelerations along radial and transverse o directions and along tangential and normal directions.

**Unit-II:** Simple Harmonic Motion, Elastic string.

**Unit-III:** Motion in a resisting medium, Motion on Smooth and rough plane curves

**Unit-IV:** Central orbits, Kepler's Laws, Inverse Square law.

**Unit-V:** Motion of a particle in three directions, Accelerations in terms of different coordinate system.

**Reference: (Books Recommended)**

1. S. L. Loney, An Elementary Treatise on the Dynamics of Particle and of Rigid Bodies.
2. P. L. Srivastava, Elementary Dynamics.
3. M. Ray and G. C. Sharma, A Textbook on Dynamics.

**Semester-V**

**Paper -I**

**BOM-501: Analysis**

**Unit-I:** Real sequences and their algebra, Limit of a sequence, Convergent, monotonic bounded and Cauchy's Sequences, Cauchy's general Principle of convergence, Convergence of Infinite series of positive terms. Cauchy's criterion, comparison test, Cauchy's nth root test.

**Unit-II:** D'Alembert's ratio test, Raabe's test, Logarithmic ratio test, Cauchy's condensation test, higher ratio test, De Morgan and Bertrand test, Alternating series, Leibnitz test, Abel's and Dirichlet's test, Absolute and conditional convergence.

**Unit-III:** Limit and continuity of functions of several variables, Repeated limits, Partial derivatives, Differentiability for functions of several variables, Mean value Theorem Taylor's theorem.

**Unit-IV:** Jacobians, Maxima, Minima and saddle points of functions of two and three variables. Lagrange's Multiplier method.

**Unit-V:** Differentiation of vector valued functions, Gradient, Divergence and curl, vector identities.

**References: (Books Recommended)**

1. Robert G. Bartle & Donald R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, Inc., New York.
2. S. C. Malik & Savita Arora, Mathematical Analysis, New Age International Publishers.
3. N. N. Bhattacharya, Elementary Analysis, Ram Narain Lal & Co.
4. T. M. Apostol, Mathematical Analysis, John Wiley & Sons, Inc., New York.
5. Mata Ambar Tiwari & R. S. Sengar, A Course in Vector Analysis with Applications.

**Paper-II**

**BOM-502: Numerical Methods**

**Unit-I:** Introduction, Need for numerical methods, floating point representation, rounding off rules.

**Unit-II:** Solution of Arbitrary Equations, Fixed point iteration methods, Bisection method, Method of False position (RegulaFalsi), Newton- Raphson's method, and order of convergence.

**Unit-III:** Interpolation, Forward, Backward and Central differences, Calculus of finite differences, Gregory-Newton Forward and Backward interpolations formulas.

**Unit-IV:** Lagrange's and Newton's divided difference interpolation formula inverse interpolation, Formulas based on Central differences, Gauss, Stirlings, Bessel's and Evertt's interpolation formula.

**Unit-V:** Cubic spline interpolation, Clamped and natural splines.

**References: (Books Recommended)**

1. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI.
2. M. K. Jain, S.R.K. Iyengar & R. K. Jain, Numerical Methods for Scientific and Engineering Computation
3. K. SankaraRao, Numerical Method for Scientist & Engineers.
4. E. Kreyszig, Advanced Engineering Mathematics.

**Paper -III**

**BOM-503: Complex Analysis**

**Unit-I:** Continuity and differentiability of functions of a complex variable. Analytic functions, Cauchy-Riemann equations, Harmonic functions.

**Unit-II:** Power series, Circle and radius of convergence, term by term differentiation, Power series representation of an analytic function, Standard exponential, trigonometric functions, logarithmic function of a complex variable, General power.

**Unit-III:** Line integrals in the Complex plane, Cauchy's Integral theorem, Cauchy's integral formula, Successive derivatives, Taylor's series.

**Unit-IV:** Laurent's series, Liouville's theorem, Morera's theorem Zeros and singularities, Rouche's theorem.

**Unit-V:** Poles of analytic function, Residues, Cauchy's residue theorem, contour integration.

**References: (Books Recommended)**

1. John B. Conway, Functions of One Complex Variable I, Springer Science & Business Media.
2. W. Rudin, Real and complex Analysis.
3. Shanti Narayan, Theory of Functions of a Complex Variables, S. Chand.
4. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House.

**Optional Papers**

**Paper-IV**

### **BOM-504: Fluid Mechanics**

**Unit-I:** Equation of Continuity in Fluid motion, Equation of Continuity in Cartesian Coordinates. **Unit-II:** Equation of Continuity in Lagrangian form, Equation of Continuity in Cylindrical and Spherical coordinates.

**Unit-III:** Stream Line, Path Line and their equations, Velocity potential, Vorticity vector.

**Unit-IV:** Boundary surfaces of fluid particles, Euler's Equations of motion for perfect fluids.

**Unit-V:** Bernoulli's Equation, Impulsive motion and its Equation.

#### **References: (Books Recommended)**

1. B. K. Sachdeva and B. D. Sharma, Elementary Hydro Dynamics.
2. A. S. Ramsey, Dynamics Part-I.
3. A. S. Ramsey, Dynamics Part-II.

### **Paper-IV**

#### **BOM-505: Operations Research**

**Unit-I:** Linear programming, Linear programming problem (LPP), Two- variable LP. Procedure of solving two- variable LPP by Graphical method, Some Important Definitions related to General LPP.

**Unit-II:** Canonical and standard forms of LPP, Slack and surplus variables, Basic solutions of LPP, Solutions of General LPP, Simplex method Big- M Method, Two Phase method.

**Unit-III:** Degeneracy in simplex methods, Solutions of simultaneous Linear equations using Simplex method, Duality concept in LPP, Formulation of Dual Problem, Duality Principle.

**Unit-IV:** Duality and Simplex Method. Important Results of Duality, Economic Interpretation of Duality and Duality theorems, Dual- Simplex Method, Limitations of Linear Programming.

**Unit-V:** Transportation and Assignment problems, Mathematical formulation of Transportation Problem, Balanced and unbalanced transportation problems, Solution of Transportation problem, Transportation table.

#### **References: (Books Recommended)**

1. H. A. Taha, Operations Research: An Introduction.
2. P. K. Gupta and D. S. Hira, Operations Research.
3. G. Srinivasan, Operations Research Principle & Applications.

### **Paper-IV**

#### **BOM-506: Discrete Mathematics**

**Unit-I:** Mathematical Logic Statements, Truth value of a statement, Logical connectives, Conjunction, Disjunction and Negation operations, Conditional and Biconditional join, Propositional functions, Tautologies and contradictions, Law of duality, Quantifiers.

**Unit-II:** Principle of Mathematical Induction, Sets, Venn-diagrams, Operations on sets, Cartesian product of sets, Relations on a sets, Composition of Relations, Equivalence Relation, Equivalence Classes, Partitions of a set, Mappings, Types of Mappings, Domain and range of a function, Composition of maps.

**Unit-III:** Partially ordered set, Hasse Diagrams, Minimal and Maximal element in a poset, least and greatest element, Upper bounds and least upper bound, Lower bounds and greatest lower bound, Isomorphic posets.

**Unit-IV:** Lattices, properties of lattices, Lattice as an Algebraic system, sub- lattices Isomorphic lattices, Bounded lattices, complete Lattices, complemented Lattices.

**Unit-V:** Boolean algebra, Principle of Duality, Switching Circuits, Logic Circuits OR Gate, AND gate, Logic Networks.

**References: (Books Recommended)**

1. J. K. Sharma, Discrete Mathematics.
2. Swapan Kumar Sarkar, A Text Book of Discrete Mathematics, S. Chand.
3. K. R. Chowdhary, Fundamentals of Discrete Mathematical Structures, PHI.

**Semester-VI**

**Paper-I**

**BOM-601: Analysis**

**Unit-I:** Riemann's Theory of integration of bounded functions over closed intervals, Riemann's criterion of integrability, Integrability of continuous and monotonic functions, Mean value theorems of Integral Calculus, The fundamental theorem of Integral Calculus.

**Unit-II:** Integration over two and three dimensional spaces, Line integrals, Green's Theorem in a plane, Surface integrals, Gauss' and Stokes' Theorems.

**Unit-III:** Improper Integrals of first and second kinds and their convergence, Comparison tests,  $\mu$ -test, Abel's and Dirichlet's tests.

**Unit-IV:** Definition and examples of metric spaces, Open and closed spheres, Open and closed sets, Interior boundary and exterior points.

**Unit-V:** Limits of subsets, Closure and interior of a set, Continuity of maps between metric spaces and their characterization.

**References: (Books Recommended)**

1. Robert G. Bartle & Donald R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, Inc., New York.
2. S. C. Malik & Savita Arora, Mathematical Analysis, New Age International Publishers.
3. T. M. Apostol, Mathematical Analysis, John Wiley & Sons, Inc., New York.
4. Arora & Bansilal, Real Analysis.

**Paper-II**

**BOM-602: Numerical Methods**

**Unit-I:** Numerical differentiation and Integration : Formulas for differentiation based on Lagrange's and on Gregory Newton's interpolation, quadrature formula Trapezoidal and Simpson's One- Third and three- eighth rules.

**Unit-II:** Numerical Methods for O. D. E.'s First order equations, incremental methods, Euler's, Taylor series and Improved Euler methods, RungeKutta method.

**Unit-III:** Multistep methods, Predictor corrector pairs, Adam's- Bash forth, Adam's- Moulton and Milne Formulas, Second Order Equations, Taylor Series method.

**Unit-IV:** Numerical Linear Algebra, Gauss Elimination, Gauss Jordan method, LU decomposition, Cholesky's Method, Diagonally dominant matrices, Gauss Jacobi and Gauss Seidel iteration formulas.

**Unit-V:** Least square approximation, Estimation of Eigen values Determination of eigenvalues and eigenvectors by iteration, Gerschgorin Theorem for positions of eigenvalues.

**References: (Books Recommended)**

1. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI.
2. M. K. Jain, S.R.K. Iyengar & R. K. Jain, Numerical Methods for Scientific and Engineering Computation
3. K. SankaraRao, Numerical Method for Scientist & Engineers.
4. E. Kreyszig, Advanced Engineering Mathematics.

**Paper-III**

**BOM-603: Tensor Calculus**

**Unit-I:** Transformation of coordinates, Contravariant and covariant vectors, Scalar, invariants, Scalar product of two vectors.

**Unit-II:** Tensors of any order, symmetric and skew- symmetric tensors, Addition and multiplication of tensors, contraction composition and quotient law.

**Unit-III:** Fundamental tensor, Associated covariant and contravariant vectors, Inclination of two vectors, orthogonal vectors.

**Unit-IV:** Christoffel symbols, Covariant derivatives of covariant and contravariant vectors, Covariant differentiation of tensors.

**Unit-V:** Curvature tensor, Ricci tensor, curvature tensor identities.

**References: (Books Recommended)**

1. U. C. De and Absos Ali Shaikh, Tensor Calculus, Narosa.
2. J. A. Schouten, Tensor Analysis for Physicists.
3. R. S. Mishra, A Course in Tensors with Applications Riemannian Geometry, Pothishala

**Optional Papers**

**Paper-IV**

**BOM-604: Fluid Mechanics**

**Unit-I:** Two dimensional fluid motion, Stream function, Cauchy Riemann Equations, Complex potential.

**Unit-II:** Concept of source and sink, Strength of source and sink, Velocity potential due to a source and sink.

**Unit-III:** Doublet, Complex potential due to doublet, Image system

**Unit-IV:** Motions of Sphere in perfect Fluid and motion of Liquid past a sphere.

**Unit-V:** Navier-Stokes equations for viscous flows-some exact solutions.

**References: (Books Recommended)**

1. B. K. Sachdeva and B. D. Sharma, Elementary Hydro Dynamics.
2. A. S. Ramsey, Dynamics Part-I.
3. A. S. Ramsey, Dynamics Part-II.

**Paper-IV**

**BOM-605: Operations Research**

**Unit-I:** Initial Basic Feasible solution, Methods of Finding Initial basic Feasible Solution, Optimality test, Modified Distribution (MOD) Method, Degeneracy of transportation problems.

**Unit-II:** Maximization Transportation Problem, Trans-shipment Problem, Game theory characteristics of Game theory, Basic Definitions, Competitive Games, Zero- Sum and Non-Zero Sum Games.

**Unit-III:** Two person zerosum games, Minimax- Maximin Criterion, Saddle Point, Solution of rectangular Games with and without Saddle Points, Minimax-Maximin Principal Dominance Property.

**Unit-IV:** Graphical Method for  $2 \times n$  and  $m \times 2$  games without Saddle point, Applications and Limitations of Game theory, Network analysis, Basic Concepts, Construction of Network diagram analysis of Network diagram.

**Unit-V:** Critical path method, Object of CPM. Labeling method, Method based on time estimates, Slack and Float, percalculation requirements for the application of CPM and PERT.

**References: (Books Recommended)**

1. H. A. Taha, Operations Research: An Introduction.
2. P. K. Gupta and D. S. Hira, Operations Research.
3. G. Srinivasan, Operations Research Principle & Applications.

**Paper-IV**

**BOM-606: Discrete Mathematics-II**

**Unit-I:** Discrete numeric functions Sum and Product of two discrete numeric functions, Generating functions, Recurrence relations.

**Unit-II:** Linear Recurrence relations with constant coefficients, Homogeneous Solution, Particular solutions, Solutions by Method of Generating function.

**Unit-III:** Graphs, Directed Graphs, In degree and Out degree of a vertex, Even and Odd vertex, Adjacent vertices, Walk, Trail, Path, Length of a Path Circuits.

**Unit-IV:**Subgraph, Spanning subgraph, Operations on graphs, Complement of a subgraph, Connected and disconnected circuit graph, Isomorphic Graph, Regular Graph, Bipartite Graph, Matrix representation of a Graph, Adjacency matrix.

**Unit-V:** Euler Graph, Properties of Eulerian Graph (Without Proof), Hamiltonian Graph, Weighted Graph, Trees, Distance and centers in a tree, Eccentricity of a vertex, radius and diameter.

**References: (Books Recommended)**

1. J. K. Sharma, Discrete Mathematics.
2. Swapan Kumar Sarkar, A Text Book of Discrete Mathematics, S. Chand.
3. K. R. Chowdhary, Fundamentals of Discrete Mathematical Structures, PHI.