**Bajaj College of Science, Wardha (Autonomous)**

**Department of Mathematics**

**B.Sc. Syllabus**

**Metrtic 1.1.3 Details of courses offered by the institution that focus on employability/entrepreneurship/skill development during the year**

**Syllabus UG (2023-24)**

**B.Sc. Sem-I (NEP)**

**DSC-1**

**Paper-I (Algebra and Trigonometry)**

**Unit I**–Number Theory: Divisibility, division algorithm, Euclidean algorithm, Diophantine equation, prime numbers, unique factorization theorem, Chinese remainder theorem, congruence, linear congruence.

**Unit II** - Matrices: Hermitian and skew- Hermitian matrices, idempotent, nilpotent, involuntary, orthogonal and unitary matrices.Rank of a matrix, Equivalent matrices, Row canonical form, Normal form, System of homogeneous and non-homogeneous equations, Eigen values and eigen vectors, Cayley-Hamilton Theorem and its applications.

**Unit III** – Theory of Equations: Relation between the roots and the coefficients of general polynomial equation in one variable, Descartes’ rule of signs, Calculation of f(x + h) by Horner’s process, Transformation of equations, Reciprocal equations.

**Unit IV** - Trigonometry: Complex number system, De Moivre’s Theorem and its application, Euler’s formula, roots of complex numbers, nth roots of unity, series expansions of circular, inverse circular and hyperbolic functions, Separation of f(z) into real and imaginary parts. Logarithm of a complex variable,Properties of logarithmic function.

**List of Practicals:**

(1) Determination of gcd and lcm of two integers using division algorithm

(2) Determination of integers x & y to satisfy g = ax + by , where g = gcd(a, b).

(3) Determination of solution of system of congruences.

(4) Determination of rank of a matrix using normal form.

(5) Solution of system of homogenious and non-homogenious linear equations.

(6) Determination of eigen values and eigen vectors.

(7) Determination of inverse of a matrix using Cayley-Hamilton theorem

(8) Determination of roots of a polynomial equation

(9) Determination of nth roots of unity using De Moivre’s theorem.

(10) Relations between Trigonometric and hyperbolic functions.

**Reference Books:**

1. Elementary Number Theory: David M. Burton (Seventh Edition), New Delhi.
2. Matrix and Linear Algebra: K. B. Datta, Prentice Hall of India Pvt. Ltd., New Delhi- 2000.
3. Higher Algebra: H.S. Hall and S.R. Knight, S. Chand & Co. Ltd., New Delhi, 2008.
4. Theory and problems of Complex variables by Murray R. Spiegel, Schaum’s outline series, McGraw-Hill Book Company, New York (1981)
5. A Textbook of Matrices: Shanti Narayan, P.K. Mittal, S. Chand & Company, 2010
6. Theory and problems of Matrices: Frank Ayres, JR., Schaum’s outline series, McGraw-Hill Book Company, New York. (1974)
7. Schaum’s Outline of trigonometry: Robert Moyer, Frank Ayres, 2012

Suggested digital platform: NPTEL / SWAYAM / MOOCs

**Paper-II (Differential Calculus)**

**Unit I** – Functions of Single Variable – Part 1: Intermediate value theorem, Rolle’s Theorem, Mean value theorems and their geometrical interpretations, Applications of mean value theorems. Maxima and Minima of a function of one variable.

**Unit II –**Functions of Single Variable – Part 2: Successive differentiation and nth differential coefficient of functions, Leibnitz’s theorem, expansion of functions, Maclaurin’s and Taylor’s theorems, Indeterminate forms and L’ Hospital’s Rule

**Unit III** - Functions of Two Variables – Part 1: Limit and continuity of functions of two variables, Partial derivatives, Homogeneous functions, Euler’s theorem, Total differentials, chain rule, differential of composite functions, Asymptotes.

**Unit IV** - Functions of Two Variables – Part 2:Jacobians and its properties, Taylor’s series of function of two variables, Maxima and Minima of function of two variables, Lagrange’s method of multiplier.

**List of Practicals:**

(1) Application of Rolle’s and Lagrange’s mean value theorem

(2) Determination of maximum / minimum value of a function of one variable

(3) Determination of nth derivative of functions and application of Leibnitz’s theorem

(4) Expansion of functions using Maclaurin’s and Taylor’s theorem

(5) Evaluation of limit of functions using L’ Hospital’s Rule

(6) Determination of partial derivatives for functions of two variables

(7) Application Euler’s theorem for homogeneous functions

(8) Determination of asymptotes of a curve and analyze through its graph.

(9) Determination of Jacobians of functions of two variables

(10) Determination of Maxima and Minima of function of two variables using Lagrange’ multiplier method.

**Reference Books:**

1. Differential Calculus: Shanti Narayan and Dr P. K. Mittal, S. Chand & Co. Ltd, New Delhi (2014).
2. Introduction to Real Analysis: R.G. Bartle & D.R. Sherbert, , John Wiley & Sons, 1999
3. Calculus: T.M. Apostal, Vol. I, John Wiley & Sons Inc., 1974
4. A Basic Course in Real Analysis: Ajit Kumar and S. Kumaresan, CRC Press, 2019
5. Differential Calculus: S. Balachandra Rao & C. K. Shantha, New Age Publication 1992
6. Calculus: H. Anton, I. Birens and S. Davis, John Wiley and Sons, Inc. 2007
7. Calculus: G. B. Thomas and R.L. Finney, Pearson Education, 2010

Suggested digital platform: NPTEL / SWAYAM / MOOCs

**VSC (2 Credits)**

**(For Maths Major subject)**

**Course Title: Finite Differences and Interpolation**

Calculus of finite differences: Introduction, basic properties, difference operators delta and E**,** relations between delta and E operators and their properties, higher order differences, construction of difference table, Factorial polynomials, representation of polynomials in the factorial notation. Interpolation: Interpolation with equal and unequal intervals.

**References :**

1. S. S. Sastri, Introductory methods of Numerical Analysis, EEE

2. B.S.Goel and S.K. Mittal, Numerical Analysis, Pragati Prakashan, Meerut.

3. Bhupendra Singh,Numerical Analysis, Pragati Prakashan, Meerut.

**List of Practical:**

1. Determination of differences of functions.
2. Representations of any polynomial in factorial notation
3. Determination of missing terms.
4. Interpolation of function for equal interval
5. Interpolation of the function for unequal interval.
6. Extrapolating the function for equal interval of arguments.

**B.Sc. Sem-II (NEP)**

**DSC-2**

**Paper-I (Integral Calculus and Ordinary Differential Equations)**

**Unit I** - Beta, Gamma Functions and Reduction Formulae: Beta and Gamma functions*,* their properties, Relation between Beta and Gamma functions, Evaluation of integrals using Beta and Gamma functions. Reduction formulae for basic trigonometric functions, Integration of irrational functions,

**Unit II** – Multiple Integrals: Double integration, Application of double integrals, Change the order of integration, Double integral in polar co-ordinates, Triple integration.

**Unit III** – First Order Differential Equations: Linear and Bernoulli’s differential equations, Exact differential equations, Integrating factors, First order higher degree differential equations solvable for x, y and p, Clairaut’s form, Orthogonal trajectories.

**Unit IV** - Second Order Linear Differential Equations: Solution of the homogeneous and non-homogeneous differential equations with constant coefficients, Euler’s Equi-dimensional Equations, Use of a known solution to find another, The method of variation of parameters.

**List of practicals:**

(1) Evaluation of Beta and Gamma functions.

1. Evaluation of integrals using Beta and Gamma functions.

(3) Evaluation of integrations of irrational algebraic functions.

(4) Evaluation of double integral by changing the order of integration.

(5) Evaluation of double integral by changing to polar coordinates.

(6) Evaluation of Area by using double integration.

(7) Solution of first order and first degree differential equations.

(8) Determination of orthogonal trajectory of the given family of curves.

(9) Solutions of second order homogeneous and non-homogeneous differential equations with constant coefficient.

(10) Solutions of differential equations by using method of variation of parameters

**Reference Books:**

(1) Integral Calculus: Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd, New Delhi (2005).

(2) Differential Equations with Applications and Historical Notes: G. F. Simmons, McGraw-Hill Inc, New Delhi (Second Edition) 1991.

(3) Calculus: T.M. Apostal, Vol. I, John Wiley & Sons Inc., 1974

(4) Calculus: H. Anton, I. Birens and S. Davis, John Wiley and Sons, Inc. 2007

(5) Calculus: G.B. Thomas and R.L. Finney, Pearson Education, 2010.

Suitable computer programs can be used: SageMath /Maxima / SciLab /etc

**Paper-II (Vector Analysis)**

**Unit I** – Vector Differentiation: Vector triple products, product of four vectors, differentiation of vectors, differentiation formulae, applications to finding tangent, normal, velocity, acceleration.

**Unit II** - Gradient, Divergence and Curl: The vector differential operator del, Gradient, directional derivatives, Divergence, solenoidal vector, Curl, irrotational vector field.

**Unit III** - Vector Integration: Ordinary integrals of vectors, Line Integral, Work done by force, exact differential and scalar potential, Surface integral, Volume integral.

**Unit IV** – Vector Theorems: Green’s Theorems in the plane (statement only), Gauss divergence Theorem (statement only), Stokes’ Theorem (statement only) and their applications.

**List of Practicals:**

(1) Determination of vector triple product and scalar triple product

(2) Determination of product of four vectors

(3) Determination of components of velocity and acceleration

(4) Determination of directional derivatives and gradient of a scalar function

(5) Determination of divergence and solenoidal vector field

(6) Determination of curl and irrotational vector field

(7) Determination of workdone by the force

(8) Determination of surface and volume integrals

(9) Determination of surface using Gauss divergence theorem

(10) Determination of line integral using Green’s theorem and Stokes’ theorem.

**Reference Books:**

1. Vector Analysis: Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd, New Delhi (2005)

1. Theory and Problems of Vector Analysis: Murray R Spiegel, Schaum’s Outline Series, McGraw-Hill Book Company, New York. (1974)
2. Introduction to Vector Analysis: N. Saran and S. N. Nigam, Pothishala Pvt. Ltd. Allahabad.

Suggested digital platform: NPTEL /SWAYAM / MOOCs

**VSC (2 Credits)**

**(For Maths Major subject)**

**Course Title: Numerical Techniques**

Solution of Algebraic and Transcendental equations: Newton-Raphson method, Regula- falsi method.

Solution of system of linear equations: Gauss-elimination method, Gauss-seidel method.

Solution of ordinary differential equations: Picard method, Eulers method, Runge-Kutta method.

**References :**

1. S. S. Sastri, Introductory methods of Numerical Analysis, EEE

2. H. K. Dass, Advanced Engineering Mathematics, S. Chand, New Delhi.

3. B.S.Goel and S.K. Mittal, Numerical Analysis, Pragati Prakashan, Meerut.

4. Bhupendra Singh,Numerical Analysis, Pragati Prakashan, Meerut.

**List of Practicals:**

1. Determination of solution of algebraic and transcendental equation using Newton-Raphson method
2. Determination of solution of algebraic and transcendental equation using Regula- falsi method
3. Determination of solution of system of linear equations using Gauss-elimination method
4. Determination of solution of system of linear equations using Gauss-seidel method
5. Determination of solution of ordinary differential equations using Picard method
6. Determination of solution of ordinary differential equations using Eulers method
7. Determination of solution of ordinary differential equations using Runge-Kutta method.

B.Sc. Sem-III

**Paper-I**

**(Partial Differential Equations & Calculus of Variations)**

**Unit I** : Origin of first order partial differential equation, formation of partial differential equations by eliminating arbitrary function and arbitrary constants. Lagrange’s linear equation of order one, Integral surface passing through given curve, Nonlinear partial differential equation of order one, Charpit’s method, special types of nonlinear partial differential equations, Jacobi’s method.

**Unit II** : Linear partial differential equation of second order with constant coefficients, solution of homogeneous and non-homogeneous linear partial differential equations with constant coefficients, Partial differential equations reducible to equations with constant coefficients.

**Unit III** : Partial differential equation of order two with variable coefficients, Classification of second order partial differential equations, characteristics of equations, Reduction to canonical form.

**Unit IV** : Functional, Continuity of functional, Linear functional, Extremum of a functional, Euler’s differential equation and applications, Invariance of Euler’s equations.

**Text Books:**

1. Elements of Partial Differential Equations,I.N. Sneddon, McGraw- Hill Book Company, 1986

2. Lectures on Partial Differential Eqations, T. M. Karade: SonuNilu, Einstein Foundation International

3.Mathematics, B.Sc. Sem III, V.M.Soni, R.K.Agrawal, N.T.Katre, R.T.Katre, N. L. Khobragade, Himalaya Publishing House, Nagpur.

**Reference Books:**

1. Advanced Engineering Mathematics, Erwin Kreyszig, John Willey and Son’s,Inc.,1999.

2. Differential Equations with Applications & Historical Notes (Second Editions), G. F. Simmons: McGraw-Hill,1991.

3. Theory and Problems of Differential Equations, Frank Ayres, McGraw-Hill Book Co., 1998.

4. Mathematics for Degree Students (B.Sc. Second year), Dr. P. K.Mittal, S.Chand and Co. Ltd.

5. Calculus of Variations with Applications, A. S. Gupta, Prentice Hall of India Pvt. Ltd., 1997.

6. Ordinary and partial differential equations, M. D. Raisinghania,S.Chand and Company Ltd.

**Paper-II (Modern Algebra)**

**Unit I** : Definition of a group, examples and properties of a group, Subgroups, Counting principle

**Unit II** :Normal subgroup, Quotient group, Homomorphism, Permutation groups, Even and odd permutations.

**Unit III:**Ring Theory: Definition and examples of rings, Some special classes of ring, Subring, Homomorphism, Ideal and quotient rings.

**Unit IV** :Integral domain, Fields, Euclidean rings, polynomial rings

**Text Books:**

1. Topics in Algebra, I. N. Herstein, Wiley Eastern Ltd., New Delhi, 1975

2.Mathematics, B.Sc. Sem III,V.M.Soni, R.K.Agrawal, N.T.Katre, R.T.Katre, N. L. Khobragade,

Himalaya Publishing House, Nagpur.

3. Lectures on Algebra, T. M. Karade: SonuNilu, Einstein Foundation International

**Reference Books:**

1. Higher Algebra, H. S. Hall and S. R. Knight, S.Chand& Co. Ltd.,New Delhi,2008.

2. Basic Abstract Algebra (2nd Edition), P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Cambridge University Press, India Edition, 1997.

B.Sc. Sem-IV

**Paper-I**

**(Real Analysis)**

**Unit I:** Bounded sets, completeness, Archimedean property of R, absolute value of real number, Neighborhood, Interior points, Open set, Limit points, closed sets, closure, Bolzano Weierstrass theorem.

**Unit II**: Sequences: Definition and examples, Bounded and Monotonic sequences, limit of a sequence, Convergent, divergent and oscillatory sequences, theorems and problems, Cauchy’s sequence – examples and theorems on Cauchy sequences, limit superior and limit inferior of sequences.

**Unit III**: Infinite Series: Series of non-negative terms, Geometric series, p-test, Comparison test, D-Alembert’s Ratio test, Cauchy’s Root test, Cauchy’s integral test, Alternating series, Leibnitz test. Absolute and Conditional convergence of series.

**Unit IV**: Riemann integration: Riemann integral, criterion for integrability, Properties of integrable functions, certain classes of integrable function. The Fundamental theorem of calculus. Mean value theorem.

**Text Books:**

1. An Introduction to Real Analysis, P.K. Jain & Kaushik, S. Chand &Co.Ltd., New

Delhi,2000.

2.Mathematics, B.Sc. Sem IV, V.M.Soni, R.K.Agrawal, N.T.Katre, R.T.Katre, N. L. Khobragade,

Himalaya Publishing House, Nagpur.

3. Lectures on Analysis, T. M. Karade: SonuNilu, Einstein Foundation International

**Reference Books:**

1. Mathematical Analysis, I.M. Apostol Narosa, Publishing House, New Delhi,1985.

2. A First Course in Mathematical Analysis, D. SomasundaranAnd B. Choudhary, Narosa Publishing House, New Delhi,1977.

3. Principles of Mathematical Analysis (Third Edition), Walter Rudin, McGraw-Hill International Edition,1976.

**Paper-II (Mathematical Methods)**

**Unit I :**Power series solution: Introduction, a review of power series, series solution of first order equations, second order linear equations, ordinary point, singular point, regular singular point, irregular singular point, Legendre’s and Bessel’s equations.

**Unit II**: Special functions: Legendre’s and Bessel’s functions with their properties, generating functions, recurrence relations, orthogonality of functions.

**Unit III:** Laplace transform: Definition of Laplace transform, Laplace transform of some elementary functions, properties of Laplace transform, Laplace transform of derivatives and integrals, Laplace transform of t.f(t), Laplace transform of f(t)/t, Inverse Laplace transform, properties of inverse Laplace transform, convolution theorem.

Solutions of ordinary differential equations with constant coefficients, solutions of simultaneous ordinary differential equations.

**Unit IV:** Fourier series: Definition and examples. Convergence of Fourier series, Fourier series of even & odd functions, Half Range Fourier Sine and Cosine series. Extension to arbitrary intervals.

**Text Books:**

1. Differential Equations with Applications & Historical Notes (Second Editions), G. F. Simmons: McGraw-Hill,1991.

2. Advanced Engineering Mathematics, H.K. Das, S. Chand & Co. 2009

3. Mathematics, B.Sc. Sem IV, V.M.Soni, R.K.Agrawal, N.T.Katre, R.T.Katre, N. L. Khobragade,

Himalaya Publishing House, Nagpur.

**Reference Books:**

1. Laplace and Fourier Transforms, Goel & Gupta, Pragati Prakashan, Meerut, 2001.

2. Laplace transform, Murray R. Spiegel, Schaum series, Mc-Graw Hill.

B.Sc. Sem-V

**Paper-I**

**Complex Analysis**

**UNIT-I:** Definition of Functions of complex variable, Limit, Continuity, Differentiability, Analytic function, Necessary and sufficient conditions for f(z) to be analytic, C-R equations in polarform. Orthogonal curves, Harmonic function, Method to find the conjugate function, Milne Thomson method.

**UNIT-II:** Transformations: Conformal transformation, Linear, Magnification, Rotation, Inversion, Reflection transformations and their combinations, Bilinear transformation, Schwarz-Christoffel transformation.

**UNIT-III:** Complex integration: Cauchy’s integral theorem, Cauchy’s integral formula, Morera Theorem, Cauchy’s inequality, Liouville’s theorem.

**UNIT-IV:** Convergence of a series of complex terms, Taylor’s theorem, Laurent’s theorem, Singular points, residue theorem, Evaluation of real definite integrals by contour integration, evaluation of improper indefinite integral.

**Text Books:**

1. Advanced Engineering Mathematics: H. K. Das, S. Chand and Co. Ltd, New Delhi (2009).

**Reference Books:**

1. Functions of a Complex Variable: Goyal & Gupta, Pragati Prakashan, 2010.

2. Complex Variables and Applications (5th Edition): R. V. Churchil and J. W. Brown,

McGraw Hill, New York, 1990

3. Theory of Complex Variables: Shanti Narayan, S. Chand & Co. Ltd., New Delhi.

4. Complex Variables (Introduction and Applications): Mark J. Ablowitz and A. S. Fokas,

Cambridge University Press, South Asian Edition, 1998

**Paper-II**

**Metric Space, Boolean Algebra & Graph Theory (Optional)**

**UNIT-I:** Countable and uncountable sets, metric spaces, Interior points, Open set, Limit points and closed sets, closure of a set, Dense set.

**UNIT-II:** Complete metric space, Compact sets , Connected sets

**UNIT-III:** Partial order relation, Partial ordered set, Lattices as Partially ordered set, Some properties of Lattices, Lattices as algebraic systems, Sub-lattices, Direct product and homomorphism, Some special lattices. Boolean algebra, Sub-algebra, Direct product and homomorphism, Boolean functions, Boolean forms and free Boolean algebra, Values of Boolean expressions and Boolean functions.

**UNIT-IV:** Graph Theory: Basic concepts, Path, Reachability and connectedness, Matrix representation of graphs, Trees, Storage representation and manipulation of graphs.

**Text Books:**

1. Introduction to Topology and Modern Analysis: G. F. Simmons, McGraw-Hill

International Edition (1963).

Scope: Chapter 1 (Articles: 6 & 7), Chapter 2 (Articles: 9 to 12)

2. Principles of Mathematical Analysis (Third Edition): Walter Rudin, McGraw Hill

International Editions, 1976.

Scope: Chapter 2 (Articles: 2.31 to 2.42, 2.45 to 2.47)

3. Discrete Mathematical Structures with Applications to Computer Science: J. P.

Tremblay, R. Manohar, Tata McGraw-Hill Pub Company, New Delhi (1997)

Scope: Chapter 2 (Articles: 2-3.8, 2-3.9), Chapter 4 (Articles: 4-1, 4-1.1 to 4-1.5, 4-2, 4-

2.1, 4-2.2, 4-3, 4-3.1, 4-3.2), Chapter 5 (Articles: 5-1, 5-2)

**Reference Books:**

1. Metric Spaces: P. K. Jain and K. Ahmad, Narosa Publishing House, New Delhi, 1968.

2. Introduction to Lattices and Order: B A. Davey and H. A. Priestley, Cambridge University

Press, Cambridge, 1990.

3. Applied Abstract Algebra, 2nd Ed.: Rudolf Lidl and Günter Pilz, Undergraduate Texts in

Mathematics, Springer (SIE), Indian reprint, 2004.

4. Discrete Mathematics with Graph Theory, 2nd Ed.: Edgar G. Goodaire and Michael M. Parmenter;

Pearson Education (Singapore) P. Ltd., Indian Reprint, 2003.

**Paper-II**

**Mechanics (Optional)**

**UNIT-I:** Forces acting at a point, Parallel forces, Moments, Couples, Coplanar forces, Reduction

theorems and examples, Equilibrium under three forces, General conditions of equilibrium,

Centre of gravity.

**UNIT-II:** Work and Energy, Virtual work, Flexible strings, Common catenary.

**UNIT-III:** Motion in a plane: Velocity and acceleration, Radial and transverse components of velocity and acceleration, Angular velocity and acceleration, Relation between angular and linear velocities, Tangential and normal components of velocity and acceleration, Newton’s Laws of motion, Projectile.

**UNIT-IV:** Basics concept of Lagrange’s Dynamics, Constraints, Generalized Coordinates, Principle of

Virtual work, D’ Alembert principle, Lagrange’s Equations, Reduction of two body central force problem to the equivalent one body problem, Central force and motion in a plane, Differential equation of an orbit, Inverse square law of force, Virial theorem.

**Text Books:**

1. Text Book of Statics: R S Varma, Pothishala Private Ltd. Allahabad (1996)

Scope: Chapters 2, 3, Chapter 4 (Articles: 4.1, 4.2, 4.4), Chapter 6 (Articles: 6.1 to 6.5),

Chapter 7, Chapter 9 (Articles: 9.2, 9.3, 9.5, 9.7, 9.8) Chapter 10 (Articles: 10.1, 10.2,

10.21, 10.22, 10.3, 10.4)

2. A Text Book of Dynamics: M Ray, S. Chand & Co. (2000)

Scope: Chapter 1 (Articles: 1.3 to 1.6, 1.8, 1.9), Chapter 3 (Articles: 3.1, 3.2)

3. Classical Mechanics: J C Upadhyaya, Himalaya Publishing House, New Delhi, 2006.

Scope: Chapter 2 (Articles: 2.2 to 2.9), Chapter 4: (Articles: 4.1, 4.2, 4.4, 4.5, 4.9)

**Reference Books:**

1. Statics: A.S. Ramsay, CBS Publishers and Distributors (Indian Reprint), 1998.

2. Statics and Dynamics with Background in Mathematics: A.P. Roberts, Cambridge

University Press, 2003.

3. Classical Mechanics (Second Edition): Herbert Goldstein, Narosa Publishing House ,

New Delhi, 1998.

4. Statics: S.L. Loney, Macmillan and Company, London.

5. An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies: S.L. Loney,

Cambridge University Press, 1956.

B.Sc. Sem-VI

**Paper-I**

**Linear Algebra**

**UNIT-I:** Vector Spaces: Definition and examples of vector spaces, Sub-spaces, Span of a set, More about sub-spaces, Linear dependence, Linear independence, Dimensions and Basis.

**UNIT-II:** Linear Transformations: Definition and examples, Range and kernel of linear map, Rank-Nullity, Inverse of a linear transformation, Consequences of Rank-Nullity Theorem.

**UNIT-III:** The space L(U, V), Composition of linear maps, Operator equations, Applications to the theory of ordinary linear differential equations, Matrix associated to linear map, Linear map associated with matrix.

**UNIT-IV:** Linear Operations in Matrices, Matrix multiplication, Rank and Nullity of a matrix, Inner product spaces, Normed linear space, Orthogonal and orthonormal vectors, Gram-Schmidt

orthogonalization process, Orthogonal and Unitary matrices, Application to reduction of

quadrics.

**Text Books:**

1. An Introduction to Linear Algebra: V Krishnamurthy, V P Mainra and J L Arora,

Affiliated East West Press Pvt. Ltd (1976).

Scope: Chapters 3, 4, Chapter 5 (Articles: 5.1 to 5.5), Chapter 7 (Articles: 7.2 to 7.4)

**Reference Books:**

1. Linear Algebra, 4th Ed.: Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence,

Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.

2. Linear Algebra and its Applications, 3rd Ed.: David C. Lay, Pearson Education Asia,

Indian Reprint, 2007.

3. Introduction to Linear Algebra: 2nd Ed., S. Lang, Springer, 2005.

4. Linear Algebra and its Applications: Gilbert Strang, Thomson, 2007.

5. Linear Algebra (A Geometrical Approach): S. Kumaresan: Prentice Hall of India, 2000

6. Basic Linear Algebra with MATLAB: S. K. Jain, A. Gunawardena and P. B. Bhattacharya, College Publishing (Springer-Verlag) 2001.

7. Matrix and Linear Algebra: K. B. Datta, M Prentice Hall of India Pvt., New Delhi, 2000

8. A Text Book of Modern Abstract Algebra: Shanti Narayan, S. Chand & Co.Ltd., New

Delhi.

**Paper-II**

**Numerical Methods (Optional)**

**Unit I:** Solution of Algebraic and Transcendental Equations: The Bisection Method, The method of

False position, The iteration method, Newton-Raphson method, Ramanujan’s method, The

Secant method, Muller’s method, Solution to systems of non-linear equations.

**Unit II:** Interpolation: Finite differences, Differences of a polynomial, Newton’s formulae for

interpolation, Central difference interpolation formulae, Interpolation with unevenly spaced

points, Divide differences and their properties, Inverse interpolation.

**Unit III:** Numerical Differentiation and Integration: Numerical differentiation, Maximum and minimum

values of a tabulated function, Numerical integration, Euler-Maclaurin formula.

**Unit IV:** Numerical Solution of Ordinary Differential Equation: Solution by Taylor’s series, Picard’s

method of successive approximation, Euler’s method, Runge-Kutta method, Predictor Corrector method, The cubic spline method, Simultaneous and higher order equations.

**Text Books:**

1. Introductory Methods of Numerical Analysis: S. S. Sastry, Prentice Hall of India (4th

Edition) (2008).

Scope: Chapter 2 (Articles: 2.2 to 2.8, 2.12), Chapter 3 (Articles: 3.3, 3.5 to 3.7, 3.9 to

3.11), Chapter 5 (Articles: 5.2 to 5.5), Chapter 7 (Articles: 7.2 to 7.8)

**Reference Books:**

1. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India,

2007.

2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and

Engineering Computation, 5th Ed., New age International Publisher, India, 2007.

**Paper-II**

**Special Theory of Relativity (Optional)**

**UNIT-I:** Review of Newtonian Mechanics: Inertial frames, Speed of light and Galilean relativity, Relative character of space and time, Postulates of Special theory of relativity, Lorentz transformation equations and its geometrical interpretation, Group properties of Lorentz transformations.

**UNIT-II:** Relativistic Kinematics: Composition of parallel velocities, Relativistic addition law for velocities, Transformation equation for components of velocities and acceleration of a particle,Transformation of Lorentz contraction factor, length contraction and time dilation.

**UNIT-III:** Geometrical representation of Space-Time: Four dimensional Minkowskian space-time ofrelativity, Space like and time like intervals, Proper time, Light cone or null cone World line of a particle, Four vector and tensors in Minkowskian space-time.

**UNIT-IV:** Relativistic Mechanics and Electromagnetism: Variation of mass with velocity. Equivalence of mass and energy i.e., E = m c2, Transformation equations for mass, momentum and energy. Relativistic force and transformation equations for its components. Relativistic Lagrangian and Hamiltonian. Maxwell’s equation in vacuum, Propagation of electric and magnetic field strengths, Four potential, Transformation equations for electromagnetic four potential vector. Transformation equations for electric and magnetic field strengths.

**Text Books:**

The Theory of Relativity: C. Molar, Oxford Clarendon Press, 1952

**Reference Books:**

1. Theory of Relativity: J.K. Gupta, K.P. Gupta, Krishna Prakashan Media (P) Ltd.

2. Lectures on Special Relativity: T. M. Karade, K.S. Adhav, M.S. Bendre, SonuNilu

3. Introduction to The Theory of Relativity: P.G. Bergman, Prentice Hall of India Pvt. Ltd., 1969

3. Principles of Relativity Physics: J.L. Anderson Academic Press, 1967

4. Special Theory of Relativity: V.A. Ugarov, Mir Publishers, 1979

5. Introduction to Special Relativity: R. Resnick, Wiley Eastern, Pvt.Ltd.1972