RASHTRASANT TUKDOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

BOARD OF STUDIES IN MATHEMATICS

B. Sc. Three Years (SIX SEMESTER) DEGREE COURSE

B.Sc. Part I (Semester I & II)

Implemented from 2020-21

B. Sc. Part II (Semester III & IV)

Implemented from 2021-22

and

B. Sc. Final (Semester V & VI)

Implemented from 2022-23

Syllabus: B. Sc. Mathematics

B. Sc. Part I (Semester I)
M-1: Elementary Mathematics

Unit I

<u>Complex Numbers</u>: De Moivre's Theorem and its application, Roots of complex number, Euler's formula, Polynomial equations, The nth roots of unity, The elementary functions.

Unit II

<u>Matrices</u>: Rank of a matrix, Equivalent matrices, Row canonical form, Normal form, Elementary matrices and rank of a product, System of homogeneous and non-homogeneous equations, Characteristic equation and roots, Cayley-Hamilton Theorem.

Unit III

<u>Theory of Equations</u>: Theorems on roots of equation, Relation between the roots and the coefficients, Formation and solutions with surd and complex roots, Descartes' rule of signs, Calculation of $f(x + h)$ by Horner's process, Transformation of equations, Reciprocal equations. Cardan's solution of Cubic equations, Ferrari's and Descartes' solution of Biquadratic equations.

Unit IV

<u>Elementary Number Theory</u>: Division Algorithm, Greatest Common Divisor, Euclidean Algorithm, The Diophantine equation $ax + by = c$, The Fundamental Theorem of Arithmetic (without proof), Basic Properties of Congruence, Linear Congruence and the Chinese Remainder Theorem.

Text Books:

1. Theory and problems of Complex variables: Murray R. Spiegel, Schaum's outline series, McGraw-Hill Book Company, New York (1981)
   Scope: Chapters 1, 2.
2. Theory and problems of Matrices: Frank Ayres, JR., Schaum's outline series, McGraw-Hill Book Company, New York. (1974)
   Scope: Chapters 5, 10, 19, 23.
3. Higher Algebra: Hall & Knight, S. Chand & Co. Ltd, New Delhi (1996)
   Scope: Chapter 3, 5 (Articles: 535 to 547, 549, 564 to 583)
4. Elementary Number Theory: David M. Burton (Seventh Edition), Tata McGraw-Hill Edition, New Delhi (2012)
   Scope: Chapters 2 (Articles: 2.2 to 2.5), Chapter 3 (Article: 3.1), Chapter 4 (Art: 4.2, 4.4)

Reference Books:

1. R. S. Verma & K. S. Shukla: Text Book on Trigonometry, Pothishala Pvt. Ltd. Allahbad.
2. A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.
3. S. H. Friedberg, A. L. Insel and L. E. Spence, *Linear Algebra*, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
4. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.
5. K. B. Datta: Matrix and Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi-2000.
6. Chandrika Prasad: Text Book on Algebra and Theory of Equations, Pothishala Private Ltd., Allahabad
7. Shanti Narayan: A Text Book of Matrices, S. Chand & Co. Ltd., New Delhi.
8. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press, Boca Raton, 2000.
9. Neville Robinns, *Beginning Number Theory,* 2nd Ed., Narosa Publishing House Pvt. Limited, Delhi, 2007.
10. George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984.

B. Sc. Part I (Semester I)
M-2: Differential and Integral Calculus

Unit I

Leibnitz's theorem, Maclaurin's and Taylor's theorems, Indeterminate forms.

Unit II

Functions of two variables and its geometrical representation, Limit and continuity of functions of two variables, Partial derivatives, Homogeneous functions, Theorems on total differentials, Composite functions, Differentiation of composite functions (without proof), Equality of mixed partial derivatives, Asymptotes, Envelopes.

Unit III

Jacobians and its properties, Taylor's series of two variables, Maxima and Minima of function of two variables, Lagrange's method of multiplier.

Unit IV

Reduction formulae, Integration of algebraic rational functions, Integration of trigonometric functions, Integration of irrational functions.

Text Books:

1. Differential Calculus: Shanti Narayan and Dr P. K. Mittal, S. Chand & Co. Ltd, New Delhi (2014).
   Scope: Chapter 5 (Article: 5.5), Chapter 6, 10, Chapter 11 (excluding 11.11), Chapter 15 (Articles: 15.1 to 15.4), Chapter 18 (Articles: 18.1 to 18.4, 18.7, 18.8)
2. Advanced Engineering Mathematics: H. K. Das, S. Chand & Co. Ltd, New Delhi (2009)
   Scope: Chapter 1 (Articles 1.15, 1.16, 1.19 to 1.21)
3. Integral Calculus: Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd, New Delhi (2005).
   Scope: Chapter 2 (Article 2.8), Chapter 3 (Articles 3.1, 3.4 to 3.6), Chapter 4 (Articles 4.1 to 4.6, 4.9, Chapter 5 (Articles 5.1, 5.4 to 5.7)

Reference Books:

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.
3. N. Piskunov: Differential and Integral Calculus, Peace Publishers, Moscow.
4. Gorakh Prasad: Differential Calculus, Pothishala Private Ltd., Allahbad.
5. Gorakh Prasad: Integral Calculus, Pothishala Private Ltd., Allahbad.
6. Ayres F. Jr.: Calculus, Schaum's Outline Series, McGraw- Hill, 1981
7. Edward J.: Differential Calculus for Beginners, MacMillan and Co. Ltd., 1963
8. Edward J.: Integral Calculus for Beginners, AITBS Publishers and Distributors, 1994
9.

<p style="text-align:center">B. Sc. Part I (Semester II)
M-3: Geometry, Differential & Difference Equations</p>

Unit I

Equation of a sphere, General equation of a sphere, The sphere through four given points, Plane section of a sphere, Intersection of two spheres, A sphere with a given diameter, A sphere through a given circle, Intersection of a sphere and a line, Plane of contact, Condition for the orthogonality of two spheres, The right circular cone, The right circular cylinder.

Unit II

Families of curves, Orthogonal trajectories, Exact equations, Integrating factors, Linear and Bernoulli's equations, Reduction of order.

Unit III

<u>Second Order Linear Differential Equations</u>: Introduction, The general solution of the homogeneous equation, The use of a known solution to find another, The homogeneous equation with constant coefficients, The method of undetermined coefficients, The method of variation of parameters.

Unit IV

<u>Difference Equations</u>: Definition, Solution of simple difference equations, Homogeneous linear equations, General solutions of higher order homogeneous linear equations with variable coefficients, Non-homogeneous equation reducible to homogeneous equation, Method of evaluating $[1/f(E)]\Phi(x)$, First order Non-homogeneous linear equations, Higher order non-homogeneous linear equations with constant coefficients, First order linear equation with variable coefficients, Equation homogeneous in $u(x)$, Equations reducible to linear equations with constant coefficients.

Text Books:

1. Analytical Solid Geometry: Shanti Narayan and Dr P. K. Mittal, S. Chand & Co. Ltd, New Delhi (2013)
   Scope: Chapter 6 (Articles: 6.1.1, 6.1.2, 6.2, 6.3.1, 6.3.2, 6.3.3, 6.4.1, 6.5, 6.6.1, 6.7.1), Chapter 7 (Articles: 7.6, 7.8)
2. Differential Equations with Applications and Historical Notes: G. F. Simmons, McGraw-Hill Inc, New Delhi (Second Edition) 1991.
   Scope: Chapter 1 (Article: 3), Chapter 2 (Articles: 8 to 11), Chapter 3 (Articles: 14 to 19)
3. Finite Differences and Numerical Analysis: H C Saxena, S. Chand & Co. Ltd. (1998).
   Scope: Chapter 8

Reference Books:

1. S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.
2. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd., 1994.
3. Gorakh Prasad and H. C. Gupta: Text Book on Coordinate Geometry, Pothishala Pvt. Ltd., Allahbad.
4. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
5. Ordinary and Partial Differential Equations (Theory and Applications) Nita H. Shah, PHI, 2010
6. E.A. Codington: An Introduction to Ordinary Differential Equations and their Applications, CBS Publisher and Distribution, New Delhi, 1985
7. H. T. H. Piaggio: Elementary Treatise on Differential Equations and Their Applications, CBS Publisher and Distribution, New Delhi, 1985
8. Erwin Kreyszig: Advanced Engineering Mathematics, John Wiley and sons, 1999

B. Sc. Part I (Semester II)
M-4: Vector Analysis

Unit I

Vector differentiation, Differential Geometry, Gradient, Divergence and Curl.

Unit II

Double integration, Evaluation of double integrals, Change of order of integration, Application of double integrals, Area in polar coordinates, Triple integration, Gamma function, Transformation of Gamma function, Beta function, Evaluation of Beta function, Symmetric property of Beta function, Transformation of Beta function, Relation between Beta and Gamma functions.

Unit III

Ordinary integral of vectors, Line integral, Surface integral, Volume integral.

Unit IV

Green's Theorems in the plane and its application, Gauss Divergence Theorem, Stokes' Theorem.

Text Books:

1. Theory and Problems of Vector Analysis: Murray R Spiegel, Schaum's Outline Series, McGraw-Hill Book Company, New York. (1974)
   Scope: Chapters 3, 4, 5 and 6.
2. Advanced Engineering Mathematics: H. K. Das, S. Chand & Co. Ltd, New Delhi (2009)
   Scope: Chapter 2, (Articles: 2.1 to 2.5, 2.7), Chapter 21 (Articles: 21.1 to 21.7)

Reference Books:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.
3. P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998
4. N. Saran and S. N. Nigam: Introduction to Vector Analysis, Pothishala Pvt. Ltd., Allahbad.
5. Erwin Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons, 1999

B. Sc. Part II (Semester III)
M-5: Partial Differential Equations & Calculus of Variations

Unit I

Simultaneous differential equations of first order and first degree in three variables, Methods of solution of $dx/P = dy/Q = dz/R$, Pfaffian differential forms and equations, Solution of Pfaffian differential equation in three variables, Partial differential equations of first order, Origins of first order partial differential equations.

Unit II

Linear equations of first order, Integral surface passing through a given curve, Compatible system of first order equations, Charpit's method, Jacobi's method.

Unit III

Partial differential equation (PDE) of second order, Linear PDE with constant coefficients and their solutions.

Unit IV

Calculus of Variations: Functionals, Classes of functions, Extremum of a functional, Variation of functional, The necessary condition for an extremum of a functional, Special cases of integrability of Euler's equation, Functional dependent on higher order derivative, Functional dependent on two functions of one independent variable, Euler-Ostrogradsky equation, Invariance of Euler's equation.

Text Book:
1. Elements of Partial Differential Equations: IAN N. Sneddon, McGraw- Hill Book Company, 1957
   Scope: Chapter 1 (Articles: 2, 3, 5, 6), Chapter 2 (Articles: 1, 2, 4, 5, 9, 10, 13)
2. Mathematics for Degree Students (B.Sc. Second year): Dr P.K. Mittal, S. Chand & Co. Ltd, New Delhi, 2011 (First edition)
   Scope: Chapters 10 and 11, Chapter 13 (Articles: 13.2 to 13.11, 13.13)

Reference Books:
1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. Ordinary and Partial Differential Equations (Theory and Applications)
   Nita H. Shah, PHI, 2010,
3. Erwin Kreyzig: Advanced Engineering Mathematics, John Willey and Son's, Inc. New York,1999.
4. A.R. Forsyth: A Treatise on Differential Equations, McGraw-Hill Book Company,1972.
5. B. Courant and D. Hilbert: Methods of Mathematical Physics (Vol I and II), Willey-interscience,1953.
6. I.M. Gelfand and S.V. Fomin: Calculus of Variables, Prentice Hill, Englewood Cliffs (New Jersey),1963.
7. A.M. Arthurs: Complementary Variational Principles, Clarendon Press, Oxford,1970.
8. V. Komkav: Variational Principles of Continuum Mechanics with Engineering Applications, (Volume I), Reidel Pup. Dordrecht, Holland,1985.
9. J.I. Oden and J.N Reddy: Variational Methods in Theoretical Mechanics, Springer-Veriag, 1976.

B. Sc. Part II (Semester III)
M-6: Modern Algebra

Unit I

<u>Group Theory</u>: Definition of a Group, Some examples of Group, Some preliminary lemma, Sub-group, A counting principle.

Unit II

Normal sub-group and Quotient Group, Homomorphism, Permutation groups.

Unit III

<u>Ring Theory</u>: Definition and examples of rings, Some special classes of rings, Homomorphisms, Ideals and Quotient rings, More ideals and Quotient rings.

Unit IV

The field of Quotients of an integral domain, Euclidean rings, A particular Euclidean ring, Polynomial rings.

<u>Text Book:</u>

1. Topics in Algebra: I. N. Hartstein, Wiley Eastern Ltd. (Second edition) 1992
   Scope: Chapter 2 (Articles: 2.1 to 2.7, 2.10), Chapter 3 (Articles: 3.1 to 3.9)

<u>Reference Books:</u>

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa, 1999.
4. P.B. Bhattachaya, S.K. Jain and S.R. Nagpaul: First Course in Linear Algebra, Willey Eastern, New Delhi,1983.
5. P.B. Bhattachaya, S.K. Jain and S.R. Nagpaul: Basic Abstract Algebra, (2nd Edition) Cambridge University Press India Edition.
6. H.S. Hall and S.R. Knight: Higher Algebra, S. Chand & Co. Ltd., New Delhi, 2008.

B. Sc. Part II (Semester IV)
M-7: Real Analysis

Unit I

Bounded sets, Completeness, Archimedean property of R, Absolute value of Real Number, Neighborhoods, Open Sets, Interior point of a set, Limit point of a set, Bolzano-Weierstrass theorem, Close sets, Closure sets.

Unit II

Sequences: Definition and examples, Bounded sequences, Convergent sequences, Monotone sequences, Subsequences, Cauchy sequences, Divergent sequences, Limit superior and limit inferior of sequences.

Unit III

Infinite series: Convergent series, Cauchy criterion of convergence of a series, Positive term series, Geometric series test, Comparison test, Limit comparison test, Ratio comparison test, p-Test, Cauchy's root test, D'Alembert ratio test, Integral test, Alternating series, Leibnitz's test, Absolute and conditional convergence.

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 Book:

1. An Introduction to Real Analysis: P K Jain and S K Kaushik, S. Chand & Co. Ltd. New Delhi, (2000)

   Scope: Chapters 1, 2, 3, Chapter 4 {Articles: 1, 2 (2.1 to 2.10), 3, 4, 5}, Chapter 8 (Articles: 1, 2, 3, 5, 6, 7)

Reference Books:

1. T. M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis,* John Wiley and Sons (Asia) P. Ltd., 2000.
3. E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
4. K.A. Ross, *Elementary Analysis- The Theory of Calculus Series-* Undergraduate Texts in Mathematics, Springer Verlag, 2003.
5. Principles of Mathematical Analysis (Third Edition) by Walter Rudin, McGraw-Hill International Edition,1976.
6. I. M. Apastol: Mathematical Analysis, Narosa Publishing house, New Delhi, 1985
7. R. R. Goldberg: Real Analysis, Oxford & IBH Publishing Co., New Delhi, 1970
8. S. Lang: Undergraduate Analysis, Springer-Verlag, New York, 1983
9. D. Somasundaram and B. Chaudhary: A First Course in Mathematical Analysis, S. Chand Co. New Delhi, 2000

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 Transforms

Laplace transform of some elementary functions, Properties of Laplace transforms, Inverse Laplace transforms, Laplace transforms of derivatives and integrals, Laplace transform of t.f(t), Laplace transform of f(t)/t, Convolution theorem, Solution of Ordinary differential equations with constant coefficients, Solution of simultaneous ordinary differential equations.

Unit IV – Fourier Series

The Fourier coefficients, The problem of convergence, Even & Odd functions, Half range cosine and sine series, Extension to arbitrary intervals.

Text Books:

1. Differential Equations with Applications and Historical Notes (Second Edition): G. F. Simmons, McGraw-Hill International Editions,1991.
   Scope: Chapter 5 (Articles: 26 to 30), Chapter 6 (Articles: 33 to 36)

2. Advanced Engineering Mathematics: H. K. Das, S. Chand and Co. Ltd, New Delhi (2009).
   Scope: Chapter 8 (Articles: 8.6 to 8.21), Chapter 13 (Articles: 13.1 to 13.12, 13.18)

Reference Books:

1. Laplace Transforms: Murray R. Spiegel, Schaum's Outline Series, McGraw-Hill
2. Laplace and Fourier Transforms: Goyal & Gupta, Pragati Prakashan, Meerut
3. Applied Mathematics (Vol II): P.N. Wartikar & J.N. Wartikar, Pune Vidyarthi Griha Prakashan, Pune

B. Sc. Final (Semester V)
M-9: 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 polar form. Orthogonal curves, Harmonic function, Method to find the conjugate function, Milne-Thomson method.

Unit II

Transformation, Conformal transformation, Transformations - Linear, Magnification, Rotation, Inversion, Reflection and their combinations, Bilinear transformation. Schwarz-Christoffel transformation.

Unit III

Complex integration, Cauchy integral theorem, Cauchy integral formula, Morera Theorem, Cauchy's inequality, Liouville Theorem.

Unit IV

Convergence of a series of complex terms, Taylor's theorem, Laurent's theorem, Singular point, Residue, Residue theorem, Evaluation of real definite integral 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).
   Scope: Chapter 7 (Articles: 7.1 to 7.47)
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Reference Books:

1. Functions of a Complex Variable by Goyal & Gupta, Pragati Prakashan, 2010.
2. R. V. Churchil and J. W. Brown: Complex Variables and Applications (5th Edition), McGraw Hill, New York, 1990
3. Shanti Narayan: Theory of Complex Variables, S. Chand & Co. Ltd., New Delhi.
4. Mark J. Ablowitz and A. S. Fokas: Complex Variables (Introduction and Applications), Cambridge University Press, South Asian Edition, 1998

B. Sc. Final (Semester V)
M-10: Metric Space, Boolean Algebra & Graph Theory (Optional)

Unit I
Countable set, Uncountable set, Metric spaces, Interior point, Open set, Limit point, Closed set, Closure of a set, Dense set.

Unit II
Complete metric space, Compact Set, Connected set.

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. P. K. Jain and K. Ahmad: Metric Spaces, Narosa Publishing House, New Delhi, 1968.
2. B A. Davey and H. A. Priestley, *Introduction to Lattices and Order,* Cambridge University Press, Cambridge, 1990.
3. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra,* 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
4. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory,* 2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2003.

B. Sc. Final (Semester V)
M-11: 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 Book:

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. A.S. Ramsay, *Statics*, CBS Publishers and Distributors (Indian Reprint), 1998.
2. A.P. Roberts, *Statics and Dynamics with Background in Mathematics*, Cambridge University Press, 2003.
3. Classical Mechanics (Second Edition) by Herbert Goldstein , Narosa Publishing House , New Delhi , 1998.
4. S.L. Loney: Statics, Macmillan and Company, London.
5. S.L. Loney: An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies, Cambridge University Press, 1956.

B. Sc. Final (Semester VI)
M-12: 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. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra,* 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
2. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
3. S. Lang, *Introduction to Linear Algebra,* 2nd Ed., Springer, 2005.
4. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.
5. S. Kumaresan: Linear Algebra (A Geometrical Approach), Prentice Hall of India, 2000
6. S. K. Jain, A. Gunawardena and P. B. Bhattacharya: Basic Linear Algebra with MATLAB, Key College Publishing (Springer-Verlag) 2001.
7. K. Hoffman and R. Kunze: Linear Algebra (2nd Edition), Prentice-Hall, Englewood Cliffs (New Jersey), 1971.
8. K. B. Datta: Matrix and Linear Algebra, Prentice Hall of India Pvt., New Delhi, 2000
9. Shanti Narayan: A Text Book of Modern Abstract Algebra, S. Chand & Co.Ltd., New Delhi.

B. Sc. Final (Semester VI)
M-13: 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.

B. Sc. Final (Semester VI)
M-14: 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 of relativity, 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., $E = m\ c^2$, 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:

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

Reference Books:

1. J.K. Gupta, K.P. Gupta, Theory of Relativity, Krishna Prakashan Media (P) Ltd.
2. T. M. Karade, K.S. Adhav, M.S. Bendre, Lectures on Special Relativity, Sonu Nilu
3. P.G. Bergman, Introduction to The Theory of Relativity, Prentice Hall of India Pvt. Ltd., 1969
3. J.L. Anderson, Principles of Relativity Physics, Academic Press, 1967
4. V.A. Ugarov, Special Theory of Relativity, Mir Publishers, 1979
5. R. Resnick, Introduction to Special Relativity Wiley Eastern, Pvt.Ltd.1972