INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)

DEPARTMENT OF MATHEMATICS

Syllabus

Bachelor of Science (B. Sc.) Semester Pattern

MATHEMATICS

(MTH/UG/2021/01)

(To be Implemented from 2021-2022)

B. Sc. (Semester Pattern) Syllabus

Semester wise Name of Papers

Subject – Mathematics

Semester	Paper	Name of the Paper	Paper Code
I	I	ELEMENTARY MATHEMATICS	BMFS11
	II	DIFFERENTIAL AND INTEGRAL CALCULUS	BMFS12
II	I	GEOMETRY, DIFFERENTIAL & DIFFERENCE EQUATIONS	BMFS21
	II	VECTOR ANALYSIS	BMFS22
III	I	PARTIAL DIFFERENTIAL EQUATIONS AND CALCULUS OF VARIATIONS	BMSS31
	II	MODERN ALGEBRA	BMSS32
IV	I	REAL ANALYSIS	BMSS41
	II	MECHANICS	BMSS42
V	I	COMPLEX ANALYSIS	BMTS51
	II	METRIC SPACES, BOOLEAN ALGEBRA AND GRAPH THEORY	BMTS52
VI	I	LINEAR ALGEBRA	BMTS61
	II*	NUMERICAL METHODS (OPTIONAL)	BMTS62
		MATHEMATICAL MODELING (OPTIONAL)	BMTS63
		DIFFERENTIAL GEOMETRY (OPTIONAL)	BMTS64
* Choose any one Paper out of three optional papers.			

Marking Scheme of Syllabus

Faculty of Science B. Sc. Semester –I to VI (Mathematics)

Semester	Paper	Total Periods / Week	Marks			Total Marks
			Theory	Internal	Total	
I to VI	I	04+1*	60	15	75	150
	II	04+1*	60	15	75	

Note : The Syllabus is based on 4 theory periods per paper and 1* tutorial period per batch per week. Theory paper is divided into four units. Each unit shall be covered in 9 hours 36 minutes. Twelve periods (of 48 minutes) are allotted for each unit. The examination shall comprise two theory papers of 3 hours duration of 60 marks each. Two internal assessments of 15 marks each are based on two theory papers.

SUBJECT: **MATHEMATICS**

B. Sc. -I SEMESTER -I

BMFS11: PAPER-I

(ELEMENTARY MATHEMATICS)

OUTCOMES

1.   Use Matrices to solve system of linear equations.

2.   Understand the concept of Eigen value & Eigen vectors and method to find it.

3.   Find roots of polynomial equation in one variable.

4.   Understand the basic concept of complex analysis.

5.   Understand the basic concept of Elementary Number Theory.

UNIT-I (9 hours 36 minutes)

Complex Numbers: 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 (9 hours 36 minutes)

Matrices: 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 (9 hours 36 minutes)

Theory of Equations: 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 (9 hours 36 minutes)

Elementary Number Theory: 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 by Murray R. Spiegel, Schaum's outline series, McGraw-Hill Book Company, New York (1981) **Scope:** Chapters 1, 2.

2.   Theory and problems of Matrices by Frank Ayres, JR., Schaum's outline series, McGraw-Hill Book Company, New York. (1974) **Scope:** Chapters 5, 10, 19, 23.

3.   Higher Algebra by Hall & Knight: S. Chand & Co. Ltd, New Delhi (1996) **Scope:** Chapter 35:(:535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 549, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 578, 579, 580, 581, 582, 583)

4.   Elementary Number Theory by David M. Burton (Seventh Edition): Tata McGraw-Hill Edition, New Delhi (2012) **Scope:** Chapters 2 (2.2, 2.3, 2.4, 2.5), Chapter 3 (Article 3.1), Chapter 4: (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.

SUBJECT: **MATHEMATICS**

B. Sc. -I SEMESTER -I

BMFS12: PAPER-II

(DIFFERENTIAL AND INTEGRAL CALCULUS)

OUTCOMES

1. Understand the concept of limit/ continuity/differentiability of two variables functions, successive differentiation and Leibnitz's theorem.
2. Understand the concept of series expansions (Maclaurin & Taylor Series).
3. Find limits of indeterminate forms by using L'Hospital Rule.
4. Understand the concept of partial differentiation, Euler's theorem, Jacobians.
5. Solve integrals using reduction formulae. Integrate algebraic rational and irrational functions.

UNIT-I (9 hours 36 minutes)

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

UNIT-II (9 hours 36 minutes)

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 (9 hours 36 minutes)

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 (9 hours 36 minutes)

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

Text Books:

1. Differential calculus by Shanti Narayan and Dr P. K. Mittal: S. Chand & Co. Ltd, New Delhi (2014). **Scope:** Chapter 5 (5.5), Chapter 6 (6.1, 6.2), Chapter 10, (10.1, 10.2, 10.3, 10.4, 10.5, 10.6), Chapter 11 (excluding 11.11), Chapter 15 (15.1, 15.2, 15.3, 15.4), Chapter 18 (18.1, 18.2, 18.3, 18.4, 18.7, 18.8)
2. Advanced Engineering Mathematics by H. K. Das, : S. Chand & Co. Ltd, New Delhi (2009) **Scope:** Chapter 1 (1.15, 1.16, 1.19, 1.20, 1.21)
3. Integral Calculus by Shanti Narayan and P. K. Mittal, : S. Chand & Co. Ltd, New Delhi (2005). **Scope:** Chapter 2 (Article 2.8), Chapter 3 (3.1, 3.4, 3.5, 3.6), Chapter 4 (4.3, 4.4, 4.5, 4.6, 4.9, Chapter 5 (5.1, 5.4, 5.5, 5.6, 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.

SUBJECT: **MATHEMATICS**

B. Sc. -I SEMESTER -II

BMFS21: PAPER-I

(GEOMETRY, DIFFERENTIAL & DIFFERENCE EQUATIONS)

OUTCOMES

1. Understand the concept of Geometry (line, Plane, Circle, Sphere, cone, cylinder).
2. Solve first order exact differential equation, first order linear differential equation.
3. Study Bernoulli's differential equation.
4. Study higher order linear differential equation.
5. Study Difference equation.

UNIT-I (9 hours 36 minutes)

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 (9 hours 36 minutes)

Families of curves, Orthogonal trajectories, Exact equations, integrating factors, linear and Bernoulli's equations, reduction of order.

UNIT-III (9 hours 36 minutes)

Second order linear differential equations: 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 undermined coefficients, The method of variation of parameters.

UNIT-IV (9 hours 36 minutes)

Difference Equations: 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 nonhomogeneous 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 by Shantinarayan and Dr P. K. Mittal,: S. Chand & Co. Ltd, New Delhi (2009) **Scope:** Chapter 6 (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 (7.6, 7.8)
2. Differential equations with applications and Historical Notes by G. F. Simmons.: McGraw-Hill Inc, New Delhi (Second Edition) 1991. **Scope:** Chapter 1(Article 3), Chapter 2 (8, 9, 10, 11)
3. Differential equations with applications and Historical Notes by G. F. Simmons Publication: McGraw-Hill Inc, New Delhi (Second Edition) 1991 **Scope:** Chapter 3 (14, 15, 16, 17, 18, 19)
4. Finite Differences and Numerical Analysis by 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

SUBJECT: **MATHEMATICS**

B. Sc. -I SEMESTER -II

BMFS22: PAPER-II

(VECTOR ANALYSIS)

OUTCOMES

1. Understand the concept of vector calculus (Gradient, Divergence, Curl).
2. Understand the concept of line integral, work done, conservative vector field.
3. Use double integration to find area.
4. Solve problems on vector Integration (Surface Integral, Volume Integral).
5. Application of Green's Theorems in the plane, Gauss divergence Theorem, Stokes' Theorem.

UNIT-I (9 hours 36 minutes)

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

UNIT-II (9 hours 36 minutes)

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 (9 hours 36 minutes)

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

UNIT-IV (9 hours 36 minutes)

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

Text Books:

1. Theory and problems of Vector Analysis by 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 by H. K. Das,.: S. Chand & Co. Ltd, New Delhi (2009) **Scope:** Chapter 2, (2.1, 2.2, 2.3, 2.4, 2.5, 2.7) Chapter 21 (21.1, 21.2, 21.3, 21.4, 21.5, 21.6, 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.

SUBJECT: **MATHEMATICS**

B. Sc. -II SEMESTER -III

BMSS31: PAPER-I

(PARTIAL DIFFERENTIAL EQUATIONS AND CALCULUS OF VARIATIONS)

OUTCOMES

1. Solve simultaneous differential equations.
2. Form partial differential equations of first order.
3. Use suitable method to find solution of partial differential equations of first order.
4. Solve linear partial differential equations of higher order.
5. Study calculus of variation.

UNIT-I (9 hours 36 minutes)

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 (9 hours 36 minutes)

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 (9 hours 36 minutes)

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

UNIT-IV (9 hours 36 minutes)

Calculus of variations: Functionals, classes of functions. 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 Books:

1. Elements of Partial Differential Equations: IAN N. Sneddon, McGraw- Hill Book Company, 1986 **Scope:** Chapter 1 (2, 3, 5, 6), Chapter 2 (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 (13.2, 13.3, 13.5, 13.6, 13.7, 13.8, 13.9, 13.10, 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.

SUBJECT: **MATHEMATICS**

B. Sc. -II SEMESTER -III

BMSS32: PAPER-II

(MODERN ALGEBRA)

OUTCOMES

1. Understand the concept of Group Automorphism.
2. Give examples of vector spaces.
3. Understand the concept of linear transformation.
4. Link linear transformations with matrices.
5. study inner product spaces.

UNIT-I (9 hours 36 minutes)

Group Theory: Definition of a Group. Some examples of Group, some preliminary lemma, Subgroup, A counting principle.

UNIT-II (9 hours 36 minutes)

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

UNIT-III (9 hours 36 minutes)

Definition and examples of rings, Some special classes of rings, Homomorphisms, Ideals and Quotient rings, More ideals and Quotient rings.

UNIT-IV (9 hours 36 minutes)

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

Text Books:

Topics in Algebra by I. N. Hrstein, Wiley Eastern Ltd. (second edition) 1992 **Scope:** Chapters 2 (2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.10), Chapters 3 (3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9)

Reference Books:

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. -II SEMESTER -IV

BMSS41: PAPER-I

(REAL ANALYSIS)

OUTCOMES

1. Understand interior point, limit point, open set, closed set and bounded set.
2. Understand the concept of convergence/divergence of sequence and series.
3. Get familiar with different tests for convergence. Find difference between Absolute, conditional convergence.
4. Understand integrability criteria. Get acquainted with Riemann integration, fundamental theorem of calculus and mean value theorem.

UNIT-I (9 hours 36 minutes)

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 (9 hours 36 minutes)

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

UNIT-III (9 hours 36 minutes)

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, Alternating series, Leibnitz's test, Absolute and conditional convergence.

UNIT-IV (9 hours 36 minutes)

Riemann Integration: Riemann integral, Criterion for Integrability, Properties of integrable function in certain classes of integrable function, The Fundamental theorem of calculus. Mean value theorem.

Text Books:

An Introduction to Real Analysis by P K Jain and S K Kaushik, S. Chand & Co. Ltd. New Delhi, (2000) **Scope:** Chapter 1, 2, 3, Chapter 4 {Articles 1, 2 (2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2,10), 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

SUBJECT: **MATHEMATICS**

B. Sc. -II SEMESTER -IV

BMSS42: PAPER-II

(MECHANICS)

OUTCOMES

1. Get acquainted with the terms moment, couple and coplanar forces.
2. Understand the concepts of equilibrium of coplanar forces, virtual work, catenary.
3. Understand the concept of radial & transverse components of velocity, radial & transverse components acceleration.
4. Understand the concept motion of projectile.
5. Understand basic concept of dynamics.

UNIT-I (9 hours 36 minutes)

Forces acting at a point, Parallel forces, Moments, Couples, Coplanar forces, Reductiontheorems and examples, Equilibrium under three forces, General conditions of equilibrium,Centre of gravity.

UNIT-II (9 hours 36 minutes)

Work and Energy, Virtual work, Flexible strings, Common catenary.

UNIT-III (9 hours 36 minutes)

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 (9 hours 36 minutes)

Basics concept of Lagrange's Dynamics, Constrain, 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 by R S Varma, Pothishala Private Ltd. Allahabad .**Scope:** Chapter 2, 3, Chapter 4 (Article 4.1, 4.2, 4.4), Chapter 6 (Article 6.1, 6.2, 6.3,6.4, 6.5), Chapter 7, Chapter 9 (Article 9.2, 9.3, 9.5, 9.7, 9.8) Chapter 10 (Article10.1, 10.2, 10.21, 10.22, 10.3, 10.4)
2.   A Text Book of Dynamics by M Ray, S. Chand & Co. (2000).**Scope:** Chapter 1(Article No 1.3, 1.4, 1.5, 1.6, 1.8, 1.9), Chapter 3(Article 3.1, 3.2)
3.   Classical Mechanics by J C Upadhyaya, Himalaya Publishing House, New Delhi, 2006.**Scope:** Chapter 2: (Article 2.2, 2.3, 2.4, 2.5. 2.6, 2.7, 2.8, 2.9), Chapter 4: (Article 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.

SUBJECT: **MATHEMATICS**

B. Sc. -III SEMESTER -V

BMTS51: PAPER-I

(COMPLEX ANALYSIS)

OUTCOMES

1. Understand the basic concepts of llimit, continuity and differentiability of functions of complex variable.
2. Understand basic concept of analytic functions.
3. Understand various transformations.
4. Study complex integration.
5. Study convergence of a series of complex terms.

UNIT-I (9 hours 36 minutes)

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 (9 hours 36 minutes)

Transformation, Conformal transformation, Transformations, Linear, magnification, rotation, Inversion, reflection and their combinations, Bilinear transformation. Schwarz-Christoffel transformation.

UNIT-III (9 hours 36 minutes)

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

UNIT-IV (9 hours 36 minutes)

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:

Advanced Engineering Mathematics by H. K. Das,:S. Chand and Co. ltd, New Delhi(2009).**Scope:** Chapters 7 (Articles 7.1 to 7.47 excluding 7.15).

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 andApplications), Cambridge University Press, South Asian Edition, 1998.

SUBJECT: **MATHEMATICS**

B. Sc. -III SEMESTER -V

BMTS52: PAPER-II

(METRIC SPACE, BOOLEAN ALGEBRA AND GRAPH THEORY)

OUTCOMES

1. Examine countable and uncountable sets.
2. Understand the concept Metric spaces, complete and compact spaces
3. Understand relations, partially ordered set, lattices, Boolean algebra and Boolean functions.
4. Understand basic concepts of graph theory.

UNIT-I (9 hours 36 minutes)

Countable set, uncountable set, Metric spaces, Interior point, open set, Limit point, closed set, Closure of a set, dense set.

UNIT-II (9 hours 36 minutes)

Complete metric space. Compact Set, Connected set.

UNIT-III (9 hours 36 minutes)

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 (9 hours 36 minutes)

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 by G. F. Simmons, McGraw-Hill International Edition (1953).**Scope:** Chapter 1 (Articles 6 & 7), Chapter 2 (Articles 9 , 10, 11, 12), Chapter 3 (Article
2. 21), Chapter 6 (Articles 31, 32, 33, 34)
3. Discrete Mathematical Structures with Applications to Computer Science by J. P.Tremblay, R. Manohar. Publication: 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, 4-1.2, 4-1.3, 4-1.4, 4-1.5, 4-2, 4-2.1, 4-2, 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.
5. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004

B. Sc. -III SEMESTER -VI

BMTS61: PAPER-I

(LINEAR ALGEBRA)

OUTCOMES

1. Understand the concept of vector space.
2. Give examples of vector spaces.
3. Understand the concept of linear transformation.
4. Link linear transformations with matrices.
5. Study inner product spaces.

UNIT-I (9 hours 36 minutes)

Vector spaces: Definition and examples of vector spaces, sub-spaces, Span of a set, More about sub-spaces, Linear dependence, independence, Dimensions and basis.

UNIT-II (9 hours 36 minutes)

Linear transformations: Definition and examples, Range and kernel of linear map, Ran-Nullity,Inverse of a linear transformation, Consequences of Rank-Nullity Theorem.

UNIT-III (9 hours 36 minutes)

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 (9 hours 36 minutes)

Linear operations in Matrices, Matrix multiplication, Rank and Nullity of a matrix, Inner product spaces, Normed linear space, Orthogonal and orthonormal vectors, Gram-Schmidt orthogonalisation process, Orthogonal and Unitary matrices, Application to reduction of quadrics.

Text Books:

An Introduction to Linear Algebra by V Krishnamurthy, V P Mainra and J L Arora:Affiliated East West Press Pvt. Ltd (1976). **Scope:** Chapter 3 (3.1, 3.2, 3.3, 3.4, 3.5, 3.5, 3.6), Chapter 4 (4.1, 4.2,4.3, 4.4, 4.5, 4.6, 4.7, 4.8), Chapter 5 (5.1, 5.2, 5.3, 5.4, 5.5), Chapter 7 (7.2, 7.3, 7.4)

Reference Books:

1.   Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra,* 4thEd., 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.

SUBJECT: **MATHEMATICS**

B. Sc. -III SEMESTER -VI

BMTS62: PAPER-II

(NUMERICAL METHODS (OPTIONAL))

OUTCOMES

1. Solve simple systems of non-linear equations adopting various methods.
2. Understand the concept of interpolation.
3. Study numerical differentiation and integration.
4. Use suitable method to find numerical solutions of ordinary differential equations.

UNIT-I (9 hours 36 minutes)

Solution of Algebraic and transcendental equations: The Bisection Method, The method of False position, The iteration method, Nwton-Raphson method, Ramanujan's method, The secant method, Muller's method, Solution to systems of non-linear equations.

UNIT-II (9 hours 36 minutes)

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 (9 hours 36 minutes)

Numerical differentiation and integration: Numerical differentiation, Maximum and minimum values of a tabulated function, Numerical integration, Euler-Maclaurin formula.

UNIT-IV (9 hours 36 minutes)

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:

Introductory methods of Numerical Analysis by S. S. Sastry: Prentice Hall of India (4th Edition) (2008). **Scope:** Chapter 2 (2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.12), Chapter 3 (3.3,3.5, 3.6, 3.7, 3.9, 3.10, 3.11), Chapter 5 (5.2, 5.3, 5.4, 5.5), Chapter 7 (7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 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. -III SEMESTER -VI

BMTS63: PAPER-II

(MATHEMATICAL MODELLING (OPTIONAL))

OUTCOMES

1. Study modelling of various systems.
2. Study Miscellaneous Mathematical models through Ordinary DEqs.
3. Study Mathematical modeling through difference equations in Economics, finance, Population Dynamics & Genetics and in Probability theory.
4. Study Mathematical Models in terms of Directed graphs, Signed graphs, Weighted digraphs.

UNIT-I (9 hours 36 minutes)

Mathematical Modelling through differential equations (DEq), Linear and Non-linear Growth and Decay models, Compartment Models, Mathematical Modelling in Dynamics, and of Geometrical problems through Ordinary DEqs of first order, Mathematical Modelling in Population Dynamics, of Epidemics, and in Economics through system of ordinary DEqs of first order, Compartment Models through systems of ordinary DEqs.

UNIT-II (9 hours 36 minutes)

Mathematical Models in Medicine, Arms Race, Battles and International trade in terms of system of ordinary DEqs, Mathematical Modelling in Dynamics through system of ordinary DEqs of first order, Mathematical Modelling of Planetary Motions, Mathematical Modelling of Circular Motions and Motion of Satellites, Mathematical Modelling through linear DEqs of

second order, Miscellaneous Mathematical models through Ordinary DEqs of second order.

UNIT-III (9 hours 36 minutes)

The need for Mathematical Modelling through difference equations, Basic theory of linear difference equations with constant coefficients, Mathematical modeling through difference equations in Economics, finance, Population Dynamics & Genetics and in Probability theory, Miscellaneous examples.

UNIT-IV (9 hours 36 minutes)

Situations giving rise to partial differential equations (PDEqs) Models, Mass-Balance equations: first method of getting PDEq Models, Momentum-Balance Equations: The second method of obtaining PDEq Models, Variational Principles: Third Method of obtaining PDEq Models, Probability Generating functions: fourth method of obtaining PDEq models, Model for Traffic flow on a Highway, Nature of PDEqs, Initial and Boudary conditions, Situations that can be Modelled through graphs, Mathematical Models in terms of Directed graphs, Signed graphs, Weighted digraphs and Unoriented graphs.

Text Books:

Mathematical Modelling by J. N. Kapur.: New Age International (P) Limited Publishers, New Delhi, 1988, Reprinted 2005. **Scope:** Chapter 2 (2.1, 2.2, 2.3, 2.4, 2.5, 2.6), Chapter 3(3.1, 3.2, 3.3, 3.4, 3.5, 3.6) Chapter 4 (4.1, 4.2, 4.3, 4.4) Chapter 5 (5.1, 5.2, 5.3, 5.4, 5.5, 5.6), Chapter 6 (6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8), Chapter 7 (7.1, 7.2, 7.3, 7.4, 7.5)

Reference Books:

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. Mathematical Modeling, models, analysis and applications by Sandip Banerjee, IIT Roorkee, Publication: CRS Press, Taylor and Francis Group, London.
3. Mathematical Modelling, A Graduate Textbook by Seyed M. Moghdas, Majid Jaberi-Douraki. Publications: Wiley publications.

SUBJECT: **MATHEMATICS**

B. Sc. -III SEMESTER -VI

BMTS64: PAPER-II

(DIFFERENTIAL GEOMETRY (OPTIONAL))

OUTCOMES

1. Study curve in space, its parametric representation, curvature of curve.
2. Understand the concept of Envelopes, developable surfaces.
3. Study curves on a surface, normal curvature.
4. Study differential equation of Geodesic, Curvature of Geodesic, Gaussian curvature.

UNIT-I (9 hours 36 minutes)

The Theory of Space Curve: Definitions, Arc length, Tangent, Normal and Binormal, Curvature and Torsion, Contact between curves and surfaces, Tangent surface, Involutes and Evolutes, Intrinsic equations, Fundamental existence theorem, Helices.

UNIT-II (9 hours 36 minutes)

The Metric: Definition of a surface, Curves on a surface, Surfaces of revolution, Helicoids, Metric, Direction coefficients, Families of curves, Isometric correspondence, Intrinsic properties, Geodesics, Canonical Geodesic equation, Normal property of Geodesic, Existence theorems, Geodesic parallels, Geodesic curvature.

UNIT-III (9 hours 36 minutes)

Gauss-Bonnet theorem, Gaussian Curvature, Surfaces of constant curvature, Conformal mapping, Geodesic mapping, The second fundamental form, Principal curvatures, Lines of curvature.

UNIT-IV (9 hours 36 minutes)

Developable surfaces, Developable associated with space curves and curves on surfaces, Minimal surfaces, Ruled surfaces, The fundamental equation of surface theory, Parallel surfaces, Fundamental existence theorem for surfaces.

Text Books:

An Introduction to Differential Geometry by T. J. Willmore, Publication: Oxford University Press, Delhi, 1997. **Scope:** Chapter 1, Chapter 2 (1 to 20), Chapter 3: (1 to 11)

Reference Books:

1. H. D. Singh & P. K. Singh, Ram Prasad and Sons, Agra-3, 1995.
2. Bansilal & Sanjay Arora, Atma Ram & Sons.
3. B. O. Nell. Elementary Differential Geometry, Academic Press, 1966.
4. S. Sternberg, Lectures on Differential Geometry, Prentice-Hall. 1976.
5. M. Docarmo : Differential Geometry of Curves and Surfaces, Prentice Hall, 1976.