

B. A. (Hons.) / B. Sc. (Hons.) Mathematics
Syllabus for Semester System

First Semester

Code	Course	Periods/ Week	Credits
BHM-101	Calculus	4	4
BHM-102	Geometry of Two and Three Dimensions	4	4

Second Semester

Code	Course	Periods/ Week	Credits
BHM-201	Differential Equations – I	4	4
BHM-202	Algebra and Complex Trigonometry	4	4

Third Semester

Code	Course	Periods/ Week	Credits
BHM-301	Functions of Several Variables	4	4
BHM-302	Group Theory	4	4
BHM-303	Programming in C	3	2

Fourth Semester

Code	Course	Periods/ Week	Credits
BHM-401	Ring Theory	4	4
BHM-402	Numerical Methods	4	4
BHM-403	<i>Lab: Numerical Methods</i>	2	2

Fifth Semester

Code	Course	Periods/ Week	Credits
BHM-501	Analysis – I	4	4
BHM-502	Differential Equations – II	4	4
BHM-503	Metric Spaces	4	4
BHM-504	Linear Algebra	4	4
BHM-505	Probability and Statistics	4	4

Sixth Semester

Code	Course	Periods/ Week	Credits
BHM-601	Analysis – II	4	4
BHM-602	Geometry of Curves and Surfaces	4	4
BHM-603	Complex Analysis	4	4
BHM-604	Operations Research and Linear Programming	4	4
BHM-605	Mechanics	4	4
BHM-606	Viva Voce		4

BHM-101: Calculus

Unit I

ϵ - δ definition of the limit of a function, Algebra of limits, Continuity, Differentiability, Successive differentiation, Leibnitz theorem, Rolle 's Theorem, Mean value theorems, Taylor's and Mclaren's series.

Unit II

Indeterminate forms, Curvature, Cartesian, Polar and parametric formulae for radius of curvature, Partial derivatives, and Euler's theorem on homogeneous functions.

Unit III

Asymptotes, Test of concavity and convexity, Points of inflexion, Multiple points, Tracing of curves in Cartesian and polar coordinates.

Unit IV

Reduction formulae, Quadrature, Rectification, Intrinsic equation, Volumes and surfaces of solids of revolution.

Books Recommended:

- Gorakh Prasad: *Differential Calculus*, Pothishalas Pvt Ltd, Allahabad.
- Gorakh Prasad: *Integral Calculus*, Pothishalas Pvt Ltd, Allahabad.
- Shanti Narayan: *Differential Calculus*, S. Chand & Co.
- Shanti Narayan: *Integral Calculus*, S. Chand & Co.
- Khalil Ahmad: *Text Book of Calculus*, World Education Publishers, 2012.

BHM-102: Geometry of Two and Three Dimensions

Unit I

General equation of second degree, Pair of lines, Parabola, Tangent, normal. Pole and polar and their properties. Ellipse, Hyperbola, Tangent, normal, pole and polar. Conjugate diameters, Asymptotes, Conjugate hyperbola and rectangular hyperbola.

Unit II

Polar equation of a conic, Polar equation of tangent, normal, polar and asymptotes, General equation of second degree, Tracing of parabola, Ellipse and hyperbola.

Unit III

Equation of sphere, Tangent plane, Plane of contact and polar plane, Intersection of two spheres, radical plane, Coaxial spheres, Conjugate systems, Equation of a cone, Intersection of cone with a plane and a line, Enveloping cone, Right circular cone.

Unit IV

Equation of cylinder, Enveloping and right circular cylinders, Equations of central conicoids, Tangent plane, Normal, Plane of contact and polar plane, Enveloping cone and enveloping cylinder, Conjugate diameters and diametral planes, Equations of paraboloids and its simple properties.

Books Recommended:

- Ram Ballabh: *Text book of Coordinate Geometry*.
- S. L. Loney: *The elements of coordinate geometry*, by Michigan Historical Reprint Series.
- Shanti Narayan, *Analytical Solid Geometry*, S. Chand and Company.
- P.K. Jain and Khalil Ahmad: *Textbook of Analytical Geometry*, New Age International (P) Ltd. Publishers.

BHM-201: Differential Equations – I

Unit I

Formulation of differential equations, Order and degree of a differential equation, equations of first order and first degree, solutions of equations in which variables are separable, Homogeneous equations, Linear equations and Bernoulli equations, Exact differential equations, integrating factors, Change of variables.

Unit II

Equations of the first order and higher degree, Equations solvable for p , y and x , Clairaut equation, Lagrange's equation, Trajectories.

Unit III

Linear differential equations with constant coefficient, Complementary function and particular integral. Particular integral of the forms e^{ax} , $\sin ax$, $\cos ax$, x^m and $e^{ax}V$, Homogeneous linear equations.

Unit IV

Linear differential equations of second order, Complete solution in terms of known integral belonging to the complementary function, Normal form, Change of independent variable, Method of undetermined coefficients, Method of variation of parameters, Simultaneous equations with constant coefficients, Simultaneous equations of form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$.

Books Recommended:

- C. H. Edwards and D. E. Penny, *Differential Equations and Boundary Value Problems: Computing and Modelling*, Pearson education, India 2005.
- Dennis G. Zill, *A first course in differential equations*,
- S. L. Ross: *Differential equations*, John Wiley and Sons, 2004.
- Zafar Ahsan: *Text Book of Differential Equations and their Applications*, Prentice Hall of India.
- Khalil Ahmad: *Text Book of Differential Equations*, World Education Publishers, 2012.

BHM-202: Algebra and Complex Trigonometry

Unit I

Relations, Types of relation, Equivalence relations, Partitions, Congruent modulo n , symmetric and skew symmetric matrices, Hermitian and skew Hermitian matrices, Elementary row operations, Elementary matrices and their properties, Singular and non-singular matrices and their properties.

Unit II

Row rank and column rank, Equivalent matrices and their properties, Similar matrices, Equivalence of row and column ranks, Row echelon and reduced row echelon forms of matrix and their properties.

Unit III

Eigen values and eigen vectors, Characteristic equation, Cayley Hamilton Theorem and its application in finding the inverse of a matrix. Application of matrices to a system of linear (both homogeneous and non-homogeneous) equations. Theorem on consistency of a system of linear equations.

Unit IV

De Moivre's theorem and its application. Circular and Hyperbolic functions. Inverse circular and hyperbolic functions. Expansion of trigonometric functions in terms of power and multiple. Separation of real and imaginary parts of logarithmic, trigonometric and inverse trigonometric functions. Summation of series including $C+iS$ method.

Books Recommended:

- I. N. Herstein: *Topics in Algebra*, Wiley; 2nd edition (June 20, 1975).
- P.B. Bhattacharya, S. K. Jain and S. R. Nagpaul: *First course in Abstract Algebra*.
- K. B. Dutta: *Matrix and Linear Algebra*.
- J. Finkbecker: *Matrix theory*.
- Ushri Dutta, A.S.Muktibodh and S.D. Mohagaonkar: *Algebra and Trigonometry*, PHI India

BHM-301: Functions of Several Variables

Unit I

Functions of several variables, Domain and range, Level curves and level surfaces, Limits and continuity, Partial derivatives, Total differential, Fundamental lemmas, differential of functions of n variables and of vector functions, The Jacobian matrix, derivatives and differentials of composite functions, The general chain rule.

Unit II

Implicit functions, inverse functions, Curvilinear coordinates, Geometrical applications, The directional derivatives, Partial derivatives of higher order, Higher derivatives of composite functions, The Laplacian in polar, Cylindrical and spherical coordinates, Higher derivatives of implicit functions, Maxima and minima of functions of several variables, Lagrange Multiplier method.

Unit III

Vector fields and scalar fields, the gradient field, Divergence and curl of a vector field, Combined operations, Irrotational and solenoidal fields, double, triple and multiple integrals, Change of variable in integrals, Surface area.

Unit III

Line integrals, Integrals with respect to arc length, Basic properties of line integrals, Green's theorem, Simply connected domains, Extension of results to multiply connected domains, Surfaces in space, Orientability, Surface integrals, Divergence theorem and Stoke's theorem, Integrals independent of path.

Books Recommended:

- Wilfred Kaplan, *Advanced Calculus*, Addison- Wesley Publishing Company, 1973.
- E. Swokowski: *Calculus with Analytical Geometry*, Prindle, Weber & Schmidt, 1984.
- E. Kreyszig: *Advanced Engineering Mathematics*, John Wiley and Sons, 1999.
- David Widder: *Advanced Calculus*, Prentice- Hall of India, 1999,
- S.C. Malik and Savita Arora: *Mathematical Analysis*, New Age International (P) Ltd. Publishers, 1996.

BHM-302: Group Theory

Unit I

Sets, relations, functions, binary operations, Definition of groups with examples and its elementary properties, subgroups, order of an element of a group, cyclic groups, coset decomposition, Lagrange's theorem and its consequences, normal subgroup and factor groups. Various types of groups up to order 8.

Unit II

Group Homomorphism, Isomorphism, kernel of a homomorphism, The homomorphism theorems, The isomorphism theorems, Permutation groups, Even and odd permutations, Alternating groups, Cayley's theorem, and Regular permutation group.

Unit III

Definition and example of Automorphism, inner automorphism, automorphism group of finite and infinite cyclic groups, conjugacy relation, normalizer and centre, External direct products, definition and examples of internal direct products.

Unit IV

Class equation of a finite group and its applications, structure of finite abelian groups, Cauchy's theorem, Sylow's theorem and consequences. Definition and example of Simple groups, non-simplicity test.

Books Recommended:

- N. Herstein, *Topics in Algebra*, Wiley Eastern Ltd., New Delhi.
- Joseph A. Gallian, *Contemporary Abstract Algebra (4th Ed)*, Narosa Publishing House, New Delhi.
- N. Jacobson, *Basic Algebra Vol. I & II*, W. H. Freeman.
- N S Gopalakrishnan, *University Algebra*, New Age International (P) Limited, New Delhi.
- Surjeet Singh and Qazi Zameeruddin, *Modern Algebra*, Vikas Publishing House Pvt. Ltd., New Delhi.

BHM-303: Programming in C

Unit-I

Number system, Programming languages, Types of programming languages, compiler, interpreter, algorithms and flowcharts.

Unit-II

Character set, Identifiers and Keywords, Data Types, Constants, Variables and basic structure of C programming, Declarations, Operators & Expressions, Statements, Preprocessor directives, Storage classes.

Unit-III

Basic Input and Output, Control Statements, Loops Statements, switch, break, Continue statements. Function prototyping, Library functions, user define functions, Passing arguments to a function, Recursion.

Unit-IV

Defining array, passing arrays to functions, Introduction to multidimensional arrays, strings. Pointers Declarations, Call by value and call by reference, pointer to array, Structures and Unions, File handling.

Books Recommended:

- E. Balagurusamy , *Programming in Ansi C*, McGraw-Hill Education
- R.K. Jain, *Flowcharts*,
- Y. Kanitkar, *Let Us C*, BPB Publications

BHM-401: Ring Theory

Unit I

Rings and their elementary properties, Integral domain, Field. Subrings, Ideals and their properties, Field of quotients, Quotient rings.

Unit II

Homomorphism of rings and its properties, Kernel of a homomorphism, Natural homomorphism, Isomorphism and related theorems, Euclidian rings, Unique factorization theorem.

Unit III

Rings of polynomials over a field F , Properties of $F[X]$, Rings of Gaussian integers, Rings of polynomials over rational field. Primitive polynomials and their properties. Gauss' Lemma and Eienstien's criterion for irreducibility.

Unit IV

Polynomial rings over commutative rings, unique factorization domain and its properties.

Books Recommended:

- I. N. Herstein, *Topics in Algebra*, Wiley Eastern Ltd., New Delhi.
- N. Jacobson: *Basic Algebra*, Volume I and II. W. H. Freeman and Co.
- Surjeet Singh and Qazi Zameeruddin: *Modern Algebra*, Vikas Publication.
- J.A. Gallian, *Contemporary Abstract Algebra*, Narosa Publication.

BHM-402: Numerical Methods

Unit1

Solution of algebraic and transcendental equations: Bisection method, False position method, Fixed-point iteration method, Newton's method and its convergence, Chebyshev method. Solution of system of non-linear equations by Iteration and Newton-Raphson method. Program in C for Bisection method, False position method and Newton's method.

Unit 2

Finite difference operators and finite differences; Interpolation and interpolation formulae: Newton's forward and backward difference, Central difference: Sterling's and Bessel's formula, Lagrange's interpolation formula and Newton's divided difference interpolation formula, Hermite interpolation. Program in C for Newton's forward and backward formula, Newton's divided difference formula.

Unit 3

Direct methods to solve system of linear equations: Gauss elimination method, Gauss-Jordan method, LU decomposition; Indirect methods: Gauss-Jacobi and Gauss-Seidal methods. The algebraic eigen value problems by Householder and Power method. Algorithms and program in C for Gauss-Jacobi and Gauss-Seidal method.

Unit 4

Numerical differentiation and Numerical integration by Newton cotes formulae, Trapezoidal rule, Simpson's rule, Romberg formula and their error estimation. Numerical solution of ordinary differential equations by Euler's method, Picard's method, Taylor series and Runge-Kutta methods. Program in C for Trapezoidal and Simpson's rule.

Books Recommended:

- B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007
- M. K. Jain, S. R. K. Iyengar and R. K. Jain, *Numerical Methods for Scientific and Engineering Computation*, New age International Publisher, India, 5th edition, 2007
- C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis*, Pearson Education, India, 7th edition, 2008.
- M. Pal : *Numerical Analysis for scientific and engineering computation*, Narosa Publication
- N. Ahmad, *Fundamental Numerical Analysis with error estimation*, Anamaya Publisher.

BHM-403: Lab: Programming in C and Numerical Methods

1. Program in C for finding greater among three numbers using conditional operators.
2. Program in C to find sum of square of natural numbers.
3. Program in C to generate prime numbers.
4. Program in C to calculate simple interest using loops.
5. Program in C to find square using function.
6. Program in C to find factorial of an integer using recursive function.
7. Program in C to generate Fibonacci numbers.
8. Program in C to check the number is Armstrong.
9. Program in C to check the number palindrome.
10. Program in C to find sum of series $(x + \frac{x^3}{3!} + \dots)$
11. Program in C to find sum of series $(1 + \frac{1}{2!} + \frac{1}{3!} + \dots)$.
12. Program in C to swap the values using call by value and call by reference.
13. Program in C to calculate area and perimeter of a circle using call by value and call by reference.
14. Program in C to find the percentage of marks using pointer.
15. Program in C to find sum of two matrices.
16. Program in C to find multiplication of two matrices.
17. Program in C to the root of non-linear equation using Bisection method.
18. Program in C to the root of non-linear equation using False position method.
19. Program in C to interpolate values using Lagrange's method.
20. Program in C to for solving system of linear equations using Gauss-Seidal method.
21. Program in C to evaluate the integral using Trapezoidal rule.
22. Program in C to evaluate the integral using Simpson's rule.

BHM-501: Analysis – I

Unit I

Bounded and unbounded sets, Infimum and supremum of a set and their properties, Order completeness property of \mathbb{R} , Archimedean property of \mathbb{R} , Density of rational and irrational numbers in \mathbb{R} , Dedekind form of completeness property, Equivalence between order completeness property of \mathbb{R} and Dedekind property. Order completeness in \mathbb{R} , Neighbourhood, Open set, Interior of a set, Limit point of a set, Closed set, Countable and uncountable sets, Derived set, closure of a set, Bolzano- Weierstrass theorem for sets.

Unit II

Sequence of real numbers, Bounded sequence, limit points of a sequence, limit inferior and limit superior convergent and non-convergent sequences, Cauchy's sequence, Cauchy's general principle of convergence, Algebra of sequences, Theorems on limits of sequences, Subsequences, Monotone sequences, Monotone convergence Theorem.

Unit III

Infinite series and its convergence, Test for convergence of positive term series, Comparison test, Ratio test, Cauchy's root test, Raabe's test, Logarithmic test, Integral test, Alternating series, Leibnitz test, Absolute and conditional convergence.

Unit IV

Continuous and discontinuous functions, Types of discontinuities, Theorems on continuity, Uniform continuity, Relation between continuity and uniform continuity, Derivative of a function, Relation between continuity and differentiability, Increasing and decreasing functions, Darboux theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's theorem with Cauchy's and Lagrange's form of remainders.

Books Recommended:

- R. G. Bartle and D.R. Sherbert, *Introduction to Real Analysis (3rd Edition)*, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2002.
- S.C. Malik and Savita Arora: *Mathematical Analysis*, New Age International (P) Ltd. Publishers, 1996.
- K. A. Ross, *Elementary Analysis: The Theory of Calculus, Under graduate Texts in Mathematics*, Springer (SIE), Indian reprint, 2004.
- Sudhir R Ghorpade and Balmohan V. Limaye, *A course in Calculus and Real Analysis, Undergraduate Text in Math.*, Springer (SIE). Indian reprint, 2004.
- T.M. Apostol: *Mathematical Analysis*, Addison-Wesley Series in Mathematics, 1974.

BHM-502: Differential Equations – II

Unit I

Series solutions of differential equations- power series method, Frobenius method, Bessel and Legendre differential equation and their series solution.

Unit II

Partial differential equations of the first order, Lagrange's solutions, Solution of some standard type of equations, Charpit's general method of solution.

Unit III

Partials differential equations of second and higher orders, Classification of linear partial differential equations of second order, Homogeneous and non-homogeneous equation with constant coefficients, Partial differential equations reducible to equations with constant coefficients, Monge,s method.

Unit IV

Calculus of variations, Variational problems with fixed boundaries, Euler's equation for functionals containing first order derivatives and one independent variable, Extremals, Functional dependent on higher order derivatives, Functional dependent on more than one independent variable, Variational problems in parametric form, Invariance of Euler's equation under coordinates transformation.

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Books Recommended:

- Dennis G. Zill, *A first course in differential equations*,
- Tyn Mint-U and Lokenath Debnath, *Linear Partial Differential Equations*
- D.A. Murray: *Introductory Course on Differential Equations*, Orient Longman (India), 1967.
- A.S. Gupta: *Calculus of variations with applications*, Prentice Hall of India, 1997.
- I.N. Sneddon: *Elements of Partial Differential Equations*, McGraw Hill Book Company, 1988.

BHM-503: Metric Spaces

Unit I

Definition and examples of metric spaces, open spheres and closed spheres, Neighbourhood of a point, Open sets, Interior points, Limit points, Closed sets and closure of a set, Boundary points, diameter of a set, Subspace of a metric space.

Unit II

Convergent and Cauchy sequences, Complete metric space, Dense subsets and separable spaces, Nowhere dense sets, Continuous functions and their characterizations, Isometry and homeomorphism.

Unit III

Compact spaces, Sequential compactness and Bolzano-Weierstrass property, Finite Intersection property, Continuous functions and compact sets.

Unit IV

Disconnected and connected sets, Components, Continuous functions and connected sets.

Books Recommended:

1. G.F. Simmons: *Introduction to Topology and Modern Analysis*, McGraw Hill, 1963.
2. E.T. Copson, *Metric spaces*, Cambridge University Press, 1968.
3. P.K. Jain and Khalil Ahmad: *Metric spaces*, Second Edition, Narosa Publishing House, New Delhi, 2003.
4. B. K. Tyagi, *first course in metric spaces*, Cambridge University Press, 2010.

BHM-504: Linear Algebra

Unit I

Definition, examples and basic properties of a vector space. Subspaces. Linear independence. Linear combinations and span. Basis and dimension. Sum and intersection of subspaces. Direct sum of subspaces.

Unit II

Definition and examples of linear transformations. Properties of linear transformations. Rank and kernel. The rank and nullity of a matrix. Rank-Nullity Theorem and its consequence. The matrix representation of a linear transformation. Change of basis. Isomorphism.

Unit III

Scalar product in R^n and C^n . Inner product spaces. Orthogonality in inner product spaces. Normed linear spaces. Inner product on complex vector spaces. Orthogonal complements. Orthogonal sets and the Gram-Schmidt process. Unitary matrices.

Unit IV

Eigenvalues and eigen vectors. Characteristic equation and polynomial. Eigenvectors and eigenvalues of linear transformations and matrices. The Caley-Hamilton Theorem. Similar matrices and diagonalization. Eigenvalues and eigenvectors of symmetric and Hermitian matrices. Orthogonal diagonalization. Quadratic forms and conic sections.

Books recommended:

- David C. Lay: *Linear algebra and its applications (3rd Edition)*, Pearson Education asia, Indian Reprint, 2007.
- Geory Nakos and David Joyner: *Linear algebra with Applications*, Brooks/ Cole Publishing Company, International Thomson Publishing, Asia, Singapore, 1998.
- Stephen H. Friedberg, Arnold J. Insel and L.E.Space- *Linear Algebra*, 4th dition, PHI Pht Ltd., New Delhi, 2004.
- I. V. Krishnamurty, V.P. Mainra, J.L. Arora- *An introduction to Linear Algebra*, East West Press , New Delhi, 2002.

BHM-505: Probability and Statistics

Unit I:

Sample space and events, algebra of events, axiomatic approaches, conditional probability, basic laws of total probability and compound probability, Bayes' theorem, Independence.

Unit- II:

Discrete and continuous random variables, mathematical expectation, variance, moment about a point, central moment, moment generating function, Binomial, Poisson, Normal and Rectangular distributions.

Unit III:

Two-dimensional random variables, joint distribution functions, marginal distributions, covariance, linear regression and correlation, rank correlation, least square method of fitting regression lines.

Unit IV:

Sampling, random sampling, large sample tests of means and proportion. t -student, χ^2 (chi square) and F distributions (without derivation) and testing of hypothesis based on them.

Reference Books

1. Irwin Miller and Marylees Miller, *John E. Freund's Mathematical Statistics with Applications*, Pearson Education.
2. Robert V. Hogg, Allen Craig Deceased and Joseph W. McKean, *Introduction to Mathematical Statistics*, Pearson Education
3. Sheldon M. Ross, *Introduction to probability and statistics for engineers and scientists*, Elsevier Academic Press.
4. J.N. Kapur and H.C. Saxena, *Mathematical Statistics*, S. Chand.

BHM-601: Analysis – II

Unit I

Definition, existence and properties of Riemann integral of a bounded function, Darboux theorem, Condition of integrability, Riemann integrability for continuous functions, bounded functions, monotonic function and functions with finite or infinite number of discontinuities (without proof). The integral as the limit of the sums, Properties of Riemann integral, Fundamental theorem of calculus, First Mean value theorems, Change of variables, Second mean value theorem, Generalised mean value Theorems.

Unit II

Definition of improper integrals, Convergence of improper integrals, Test for convergence of improper integrals Comparison test, Cauchy's test for convergence, Absolute convergence, Abel's Test, Dirichlet's Test, Beta and Gamma functions and their properties and relations.

Unit III

Definition of pointwise and uniform convergence of sequences and series of functions, Cauchy's criterion for uniform convergence, Weierstrass M-test, Uniform convergence and continuity, Uniform convergence and differentiation, Uniform convergence and integration..

Unit IV

Fourier Series, Fourier Series for even and odd functions, Fourier Series on intervals other than $[-\pi, \pi]$. Power series, Radius of convergence, uniform and absolute convergence, Abel's Theorem (without proof), exponential and logarithmic functions.

Books Recommended:

- R. G. Bartle and D.R. Sherbert, *Introduction to Real Analysis* (3rd Edition), John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2002.
- S.C. Malik and Savita Arora: *Mathematical Analysis*, New Age International (P) Ltd. Publishers, 1996.
- K. A. Ross, *Elementary Analysis: The Theory of Calculus, Under graduate Texts in Mathematics*, Springer (SIE), Indian reprint, 2004.
- Sudhir R Ghorpade and Balmohan V. Limaye, *a course in Calculus and Real Analysis, Undergraduate Text in Math.*, Springer (SIE). Indian reprint, 2004.
- T.M. Apostol: *Mathematical Analysis*, Addison-Wesley Series in Mathematics, 1974.

BHM-602: Geometry of Curves and Surfaces

Unit I

Curves in R^3 , Representation of curves, Unit and arbitrary speed curves, Tangent, Principal normal and binormal, Curvature and torsion, Frenet formula.

Unit II

Behaviour of a curve near one of its points, The curvature and torsion of a curve as the intersection of two surfaces, Contact between curves and surface, Osculating circle, and osculating sphere, involutes and evolutes, Helics.

Unit III

Introduction of Differential forms, covariant derivative, Frame field and connection forms, Surfaces in R^3 , examples, tangent plane and surface normal, Orientability, The first fundamental form and its properties.

Unit IV

Direction coefficients on a surface, orthogonal trajectories, Double family of curves, Second fundamental form, normal curvature, principal curvature, Gaussian and mean curvature.

Books recommended:

- Barrett O'Neill, *Elementary Differential Geometry*, Academic Press.
- W. Klingenberg, *A course in differential geometry*, Spriger-Verlag.
- T. Willmore, *An introduction to Differential Geometry*, Clarendon Press, Oxford C.
- E. Weatherburn, *Differential Geometry of three dimensions*, University press, Cambridge.

BHM-603: Complex Analysis

Unit I

Complex numbers as ordered pairs, Geometrical representation of complex numbers, stereographic projection, Limit and continuity, Complex derivative, Derivative and Analyticity, analytic functions, Cauchy-Riemann equations, Harmonic equations.

Unit II

Elementary functions, Exponential functions, Trigonometric functions, Hyperbolic functions, Logarithmic functions, Analyticity of Log functions, Inverse trigonometric and Hyperbolic functions. Mapping by elementary functions, Mobius Transformations, Fixed points, Cross ratio, Inverse points and critical mappings, Conformal mappings.

Unit III

Integration of complex-valued functions, Contours, Contour integrals, Anti derivatives, Cauchy Theorem (without proof), Simply and multiply connected regions, Cauchy integral formula (without proof), Line integration, Complex line integration, Contour integration and Green's theorem (without proof), Path Independence, Indefinite Integrals, Fundamental theorem of calculus in the complex plane.

Unit IV

Convergence of sequences and series, Taylor series, Laurent series, Maclaurin series.

Books Recommended:

- R. V. Churchill and J. W. Brown: *Complex Variables and Applications*, McGraw Hill Publishing Company, 1990.
- E. Hille: *Analytic Functions Theory*, Vol. 2, Ginn and Co. 2nd Ed. New York, 1973.
- E. B. Saff and A. D. Snidder: *Fundamental of Complex Analysis with Applications to Engg. and Science*, Pearson Education.
- A. David Wunsch, *Complex Variables with Applications*, Pearson Publication, 2009.
- Punnuswamy: *An Introduction to Complex Analysis*, Narosa Publication.

BHM-604: Operations Research and Linear Programming

Unit I:

Operations Research (OR) and its Scope, Modeling in OR, Scientific Method in Operations Research, Linear Programming: Definition, mathematical formulation, standard form, Solution space, solution – feasible, basic feasible, optimal, infeasible, multiple, redundancy, degeneracy, Solution of LP Problems - Graphical Method, Simplex Method.

Unit- II:

Duality in LP, Dual Simplex Method, Economic interpretation of Dual, Transportation Problem, Basic feasible solution using different methods (North-West corner, Least Cost, Vogel's Approximation Method), Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Assignment Problem, Hungarian Method for Assignment Problem.

Unit III:

Elementary inventory models, Replacement models, Group replacement problem, Sequencing theory, m machines and n jobs problem, Graphical method for sequence problem.

Unit IV:

Game Theory, pure and mixed strategies, Saddle point, Two-Persons-Zero-Sum Game, Game with mixed strategies, Dominance rule, Graphical Method, Inter - relation between the theory of games and linear programming, Solution of game using Simplex method.

Books Recommended:

- J. K. Sharma, *Operations Research – Theory and Application*, Macmillian Pub.
- J. K. Sharma, *Operations Research – Problems and Solutions*, Macmillian Pub.
- G. Hadly, *Linear Programming*, Narosa Publishing House
- A. H. Taha, *Operations Research – An Introduction*. Prentice Hall
- Hillier and Lieberman, *Introduction to Operations Research*, McGraw Hill.

BHM-605: Mechanics

Unit I

Basic Concept of Mechanics: - Fundamental laws of Newtonian mechanics, inertial frame of reference, particle, mass, rigid body force, external and internal forces, forces acting at a point, triangle law of forces and polygon law of forces, Lami's theorem, equilibrium of a system of particles, necessary conditions for equilibrium of forces.

Unit II

Moments, moment of a force about a point and a line, parallel forces, couple, theorem of Varignon, Necessary conditions for equilibrium (moment), Coplanar forces, Reduction of a general plane force system, parallel force system in two and three dimensions.

Unit III

Centre of gravity and centre of parallel forces, Centre of gravity of some simple bodies: rod, triangle, arc, plane area, surface of revolution, sum of difference of two bodies, segment of a sphere and some simple curves, Work and Energy, Conservative field and potential energy, Principle of conservation of energy for a particle.

Unit IV

Components of velocity and acceleration (Cartesian, radial and transverse, tangential and normal), uniformly accelerated motion, Resisted motion, Projectile and motion in a non-resisting medium, Constrained motion on a smooth vertical circle, collisions (direct).

Books Recommended:

- Statics, *A. S. Ramsey*, Cambridge University Press
- A Text book of Dynamics, *F. Chorlton*, CBS Publishers & Distributors Pvt Ltd
- Dynamics Part-1 and 2, *A. S. Ramsey*, Cambridge University Press.
- Classical Mechanics, *Goldstein*, Pearson Education.
- Principle of Mechanics, *Synge and Griffith*, Mcgraw-Hill Book Company.