B.A./B.Sc. (Hons.) I Semester
Mathematics
Course Title: Calculus
Course Number: MMB151
Credits: 04
No. of Periods/week 04

Unit – I (14 Lectures)

Successive differentiation: Derivatives of higher order, nth derivative of well-known functions, Leibnitz's theorem (without proof). Expansion of functions, Maclaurin's theorem and Taylor's theorem (without proof), Indeterminate forms: $\frac{0}{0}$, $\frac{\infty}{\infty}$, 0 x ∞, $\infty - \infty$, and 0^0, 1^∞, ∞^0. Asymptotes of the algebraic curves, parallel asymptotes, Asymptotes parallel to x-axis and y-axis.

Unit- II (14 Lectures)

Curvature: Angle between radius vector and tangent, derivative of arc length in cartesian, parametric and polar form, Calculation of curvature in cartesian, parametric and polar form. Radius of curvature in the three forms, Multiple points, convexity and concavity of a curve, points of inflexion, Tracing of cartesian curves, Idea of some well known polar curves, Functions of two or more variables, partial differential coefficients, Homogeneous functions, Euler's theorem on homogeneous functions.

Unit- III (14 Lectures)

Gamma functions, Integration of the type $\int_0^{\frac{\pi}{2}} Sin^m x\, Cos^n x\, dx$, Length of curves for cartesian, parametric and polar equations, Intrinsic equation from cartesian, parametric and polar equations, Volume and Surfaces of solids of revolution of cartesian, parametric and polar curves.

Unit- IV (10 Lectures)

Exact differential equations. Integrating factors. Total differential equations. Differential equations of first order but not of first degree. Equations solvable for p, y and x. Clairaut's equations.

Books recommended

1. Differential Calculus by Gorakh Prasad, Seventeenth Edition, Reprint 2007,
2. Integral Calculus by Gorakh Prasad, Fourteenth Edition, Reprint 2007, Pothishala Private Limited, Allahabad.
3. Differential Equations and Their Applications by Zafar Ahsan, Second Edition, Prentice-Hall of India Private Limited, New Delhi.

Reference Book

1. Differential and Integral Calculus by N. Piskunov.

B.A./B.Sc. (Hons.) I Semester
Mathematics
Course Title: Geometry I
Course Number: MMB152
Credits: 02
No. of Periods/week=03

UNIT – I: General Equation of Second Degree (10 lectures)

5.1 General Equations. 5.11 pair of straight line through origin, 5.7 lines joining the origin to the intersection of a curve and a line. 6.1 The conic section, 6.2 Equation to a conic section. 6.3 Intersection of a straight line and a conic. 6.31 Equation of a tangent to a conic, 6.32 Condition of tangency. 6.33 Pair of tangents from a point.

UNIT – II: Conic Sections (10 lectures)

6.34 Chord of contact of a pair of tangents to a conic. 6.4 Pole and polar 6.41 Conjugate points. 6.42 Conjugate lines. 6.43 The condition of conjugacy. 6.5 Chord with a given middle point. 6.6 Centre of a conic and diameter. 6.7 Equation of the conic when the origin is transferred to the centre. 6.8.1 Conjugate diameters.

UNIT –III: Tracing of Conic (10 lectures)

4.2 Change of rectangular axes without change of origin. 4.5 Removal of xy-term. 4.6 Invariants. 12.1 Nature of conic, 12.12 Summary. 12.2 Tracing of Parabola, 11.3 the asymptotes of hyperbola. 11.4 conjugate hyperbola (Example on pp. 211). 12.3 Asymptotes. 12.4 The length and position of axes. 12.4 Coordinate of foci.

UNIT –IV: Polar Equations (10 lectures)

13.1 Polar equation of a conic when focus is at the pole. 13.11 Directrices, 13.12 Tracing of the conic $\frac{l}{r} = 1 + e\cos\theta$. 13.13 Equation of the Chord when the vectorial angles of the extremities are given. 13.21 Equation of the tangent at the point whose vectorial angle is α. 13.22 normal, 13.3 Polar.

Books Recommended:

1. Ram Ballabh**:** Coordinate Geometry, Prakashan Kendra, Lucknow (13th Revised Edition).

B.A./B.Sc. (Hons.) II Semester
Mathematics
Course Title: Numerical Analysis
Course Number: MMB251
Credits: 04

Unit I: (15 Lectures)
Absolute, relative and percentage errors, General error formula, Error in series approximation, Solution of algebraic and transcendental equations, The bisection and Regula falsi method, Iteration methods namely, Newton-Raphson method, Generalized Newton's method, Solution of system of linear equations using direct methods such as matrix inversion, Gauss elimination and LU decomposition including some iteration methods namely, Jacobi and Gauss-Siedel methods, The algebraic eigen value problems using iterative and Householder methods.

Unit II: (12 Lectures)
Symbols of Δ,∇, E, E^{-1}, D, μ and δ and their relations, Newton-Gregory Forward and Backward difference formulae, Gauss's, Stirling's and Bessel's formulae, Lagrange's formula, Divided Differences and their properties, Newton's general interpolation formula, Inverse interpolation formula and Interpolation with cubic splines.

Unit III: (15 Lectures)
Numerical Differentiation and Integration, Numerical differentiation of tabular and non-tabular functions including error estimations, Numerical integration using Gauss quadrature formulae, Trapezoidal, Simpson's 1/3- and 3/8-Rule, Weddle's Rule and Newton-Cotes Formula including error estimation, Curve fitting and approximations, Least squares curve fitting procedures, Different types of approximations, Least squares polynomial approximation, Chebyshev polynomials and its application in various approximations.

Unit IV: (10 Lectures)
Ordinary differential equations, Euler's and modified Euler's methods, Picard's method, Taylor series method, Runge-Kutta methods of 2^{nd} and 4^{th} order, Multi-step methods, Milne-Simpson method, Adam Bashforth-Moulton method, Boundary value problems using Finite Difference method.

Text Books:

1. **S.S. Sastry,** Introductory Methods of Numerical Analysis (Fifth Ed.), Prentice Hall of India (Ltd.) New Delhi-110001, 2012.

Reference Books:

1. M.K. Jain, S.R.K. Iyenger and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd., 1999.

B.A./B.Sc. (Hons.) (II Semester)
GEOMETRY II
MMB-252
Credits: 02
No. of Periods/week=03

UNIT–I: STRAIGHT LINE, PLANE AND CYLINDER (10 lectures)

16.2& 16.22 Direction cosines of a line. 16.3&16.31 Projection of a segment. 16.4 Angles between two lines (with Corollaries 1,2&3). 16.5 Distance of a point from a line. 16.6 &16.61. Equation of a plane. 16.63 Length of perpendicular from a point to a plane.17.1& 17.2 Cylinder and its Equation. 17.3 Right circular cylinder. 17.31 Equation of a right circular cylinder.

Problems. $\frac{Ex.2,4.}{p.314}, \frac{Ex.2}{p316}, \frac{Ex.3}{p318}, \frac{Exp.}{p.356}, \frac{Ex.1-6}{p.357}$. **Home Assignment.** $\frac{Ex.1,3,6.7}{p.314}, \frac{Ex.1,2,4}{p318}$.

UNIT –II: CONE (10 lectures)

17.4 Equation of a cone. 17.6 Equation of a cone when the vertex is at the origin. 17.61 Condition for general equation of second degree to represent a cone. 17.7 Tangent plane to a cone, 17.71 A property of the tangent plane to a cone. 17.72 Condition of tangency. 17.8 Reciprocal cone. 17.9 Cone with three mutually perpendicular generators, 17.91 Number of mutually perpendicular generators.

Problems. $\frac{Exp.}{p.360}, \frac{Ex.5-10}{p.361,362}, \frac{Exp.}{p.365}, \frac{Ex.4-6}{p.366}, \frac{Ex.3,5-11,13,16-19}{p.367-369}$.

Home Assignment. $\frac{Ex.1-4}{p.360,361}, \frac{Ex.11,12}{p.362}, \frac{Ex.1,3,7}{p.366}, \frac{Ex.4,12,14,15,20,21}{p.367-369}$

UNIT –III: CENTRAL CONICOIDS (10 lectures)

18.1 The standard equation of central conicoids. 18.2 The tangent plane. 18.21 Condition of tangency of a plane. 18.3 Section with a given centre. 18.4 Locus of the mid-points of a system of parallel chords. 18.5 The Polar plane, 18.51 Polar lines. 18.6 Enveloping cone.

Problems. $\frac{Ex.3,5,6,8}{p.374-375}, \frac{Ex.12,13,17,}{p.376}$. **Home Asmt.** $\frac{Ex.1,2,4,7,9,10}{p.374-375}, \frac{Ex.14,16}{p.376}$

UNIT–IV: Diametral Planes (of an Ellipsoid) and Paraboloids (10 lectures)

18.7 Classification of central conicoids. 18.8 The Normal. 18.81 Normals from given point. 18.9 Conjugate diametral plane and diameters of Ellipsoid. Paraboloid (elliptic and hyperbolic). Tangent plane to a paraboloid.

Problems. $\frac{Ex.1,2,6,7}{p.378-381}, \frac{Ex.2}{p.384}, \frac{Ex.2,3,5,9,11,13,15}{p.385-387}$.

Home Assignment. $\frac{Ex.3,5}{p.379}, \frac{Ex.1}{p.385}, \frac{Ex.7,10}{p.386-387}$

Book Recommended:

1. Coordinate Geometry- Ram Ballabh, Prakashan Kendra, Lucknow (13^{th} Revised Edition).
2. An Elementary Treatise on Coordinate Geometry- R.J.T.Bell, MacMillon&Co.Ltd.1960

B.A./B.Sc. (Hons.) III Semester
Mathematics
Course Title: Algebra–I
Course Number: MMB351
Credits: 04

Unit- I (16 Lectures)

Binary operations, definitions of Group, Ring and Field with examples, vector spaces, subspaces, span of a set, sum of subspaces, linear dependence and independence, dimension and basis, coordinates of a vector relative to the ordered basis, dimension theorem.

Unit- II (12 Lectures)

Linear transformation and its properties, range and kernel of a linear transformation, rank and nullity of linear transformation, rank-nullity theorem, inverse of linear transformation.

Unit- III (12 Lectures)

The vector space L(U,V) and its dimension, composition of linear transformations, matrix associated with a linear transformation, linear transformation associated with a matrix, matrix as a linear transformation and its rank and nullity.

Unit- IV (12 Lectures)

Elementary row operations and row- reduced echelon form, inverse of a matrix through elementary row operation, solution of a system of linear equations, eigen-values, eigen-vectors.

Books recommended

1. V. Krishnamurthy, V.P. Maurya & J. L. Arora: An introduction to Linear Algebra
2. Surjeet Singh: Modern Algebra.

B.A./B.Sc. (Hons.) III Semester
Mathematics
Course Title: Ordinary Differential Equations
Course Number: MMB352
Credits: 02

Unit I

Linear differential equations of order n. Homogeneous and non-homogeneous differential equations of order n with constant coefficients. Complementary functions. Different forms of particular integrals. Linear differential equations with non-constant coefficients. Reduction of order method.

Unit II

The Cauchy-Euler's equation of order n. The Legendre's linear equation. Methods of undetermined coefficients and variation of parameters. Series solution of differential equations. Frobenius method. Different cases.

Unit III

Bessel, Legendre and hypergeometric differential equations and their solutions. Simultaneous total different equations. Equations of the form dx/P=dy/Q=dz/R. Methods of grouping and multipliers. Solution of a system of linear differential equation with constant coefficients. An equivalent triangular system. Degenerate case.

Unit IV

Laplace transforms. Linearity of Laplace transforms. First shifting property. Table of Laplace transforms. Inverse Laplace transforms. Laplace transform of derivative and integrals. Unit step function and its Laplace transform. Second shifting property. Unit impulsive function and its Laplace transform. Convolution and periodic function theorems. Solution of linear differential equations with constant coefficients using Laplace transform methods.

Book Recommended

1. Zafar Ahsan: Differential Equations and their Applications, Prentice Hall of India, New Delhi (2^{nd} Edition, 13^{th} reprint May 2012).

B.A./B.Sc. (Hons.) IV Semester
Mathematics
Course Title: Advanced Calculus
Course Number: MMB451
Credits: 04

Unit I (12 Lectures)
Functions of several variables, Contour lines, Level curves and level surfaces, Limits and continuity for functions of two and more variables, Partial derivatives, Partial derivatives and continuity, Differentiability, The chain rule for functions of two and three variables.

Unit II (12 Lectures)
Directional derivatives, Gradient vectors, Tangent planes, Linearization and differentials, Extreme values and saddle points, Local and absolute maxima / minima, The method of Lagrange multipliers (with one constraint only), Taylor's series for function of two variables, Partial derivatives with constrained variables.

Unit III (12 Lectures)
Double integral over a rectangle region, Double integral as volume, Double integral over non rectangular regions, Fubini's Theorem, Area of a region in a plane, Transformation of double integral from Cartesian to polar co-ordinates and vice-versa, Spherical and cylindrical co-ordinates, Triple integral in Cartesian, Cylindrical and spherical co-ordinates.

Unit IV (12 Lectures)
Line integral, Gradient field, Green's Theorem in a plane, Evaluation of line integral using Green's Theorem, Surface Area, Surface integral, Strokes Theorem.

Text Book:

1. G. B. Thomas, M. D. Weir, J. Hass: Thomas' Calculus (Twelfth Edition), Pearson Education.

Reference Books:

1. D. V. Widder: Advanced Calculus (Second Edition), Prentice Hall of India Pvt. Ltd., New Delhi, 1994.
2. S. C. Malik and S. Arora: Mathematical (Second Edition), Wiley Eastern Ltd., New Delhi, 1994..
3. N. Piskunov: Differential and Integral Calculus, Vol. I and II, CBS Publishers and Distributors, New Delhi, 1994.

B.A./B.Sc. (Hons.) IV Semester
Mathematics
Course Title: Partial Differential Equations
Course Number: MMB452
Credits: 02

Unit I: First order P.D.E.

Definition of a partial differential equation, Formation of partial differential equations, Classifications of first order partial differential equations (quasi-linear, semi-linear, linear, nonlinear) and their solutions, Equations easily integrable, Solution of quasi-linear partial differential equations of first order: Lagrange's equations, Integral surfaces of first order partial differential equations through a given curve, Non-linear partial differential equation of first order and their different forms, Charpit's method, Jacobi's Method, Compatible systems of first order partial differential equations.

Unit II: Higher order P.D.E.

Homogeneous linear partial differential equations of higher order with constant coefficients, Different cases for complimentary functions and particular integrals, Non-homogeneous partial differential equations of higher order with constant coefficients, Equations reducible to linear partial differential equations with constant coefficients, Solutions of nonlinear partial differential equations of second order: Monge's Method, Method of separation of variables.

Unit III: Higher order P.D.E. (cont.)

Fourier series, Dirichlet's conditions, Even and odd functions and their Fourier series, Change of interval, One dimensional wave equation and its solution, One dimensional heat equation and its solution, Laplace equation and its solution, Solutions of partial differential equations of second order using Laplace transform methods.

Unit IV: Calculus of variations

Variation of a functional, Variational problems, Euler's equations and its various cases, Exteremals, Functional depending on n unknown functions, Functionals depending on higher derivatives, Variational problems in parametric form, Isoperimetric problem, Functionals depending on functions of several independent variables: Ostrogradsky's equation.

Text Book

1. ZafarAhsan: Differential Equations and their Applications, Prentice Hall of India, New Delhi (3rd Edition, August 2016).

Reference Books

2. K. S. Rao: Introduction to Partial Differential Equations, Prentice Hall of India, New Delhi (2nd Edition, May 2009).
3. T. Amaranath: An Elementary Course in Partial Differential Equations, Narosa Publishing House, New Delhi (2nd Edition, reprint July 2014).

Open Elective

B.A./B.Sc. (Hons.) IV Semester

Course Title: Elementary Mathematics

Course Number: MMB---

Credits: 02

Unit 1: Relations and Functions

Definition of relation, pictorial diagrams, domain, co-domain and range of a relation. Ordered pairs, Cartesian product of sets. Number of elements in the Cartesian product of two finite sets. Cartesian product of the reals with itself. Types of relations: Reflexive, symmetric, transitive and equivalence relations. One to one and onto functions, composite functions, inverse of a function. Binary operations. Function as a special kind of relation from one set to another. Pictorial representation of a function, domain, co-domain and range of a function. Real valued function of the real variable, domain and range of these functions, constant, identity, polynomial, rational, modulus, signum and greatest integer functions with their graphs. Sum, difference, product and quotients of functions.

Principle of Mathematical Induction: Process of the proof by induction, motivating the application of the method by looking at natural numbers as the least inductive subset of real numbers. The principle of mathematical induction and simple applications.

Unit 2: Linear Inequalities and Permutation and combination

Linear inequalities, Algebraic solutions of linear inequalities in one variable and their representation on the number line, Graphical solution of linear inequalities in two variables. Solution of system of linear inequalities in two variables-graphically.

Fundamental principle of counting. Factorial n. Permutations and combinations derivation of formulae and their connections, simple applications.

Unit 3: Matrices and Determinants:

Concept, notation, order, equality, types of matrices, zero matrix, transpose of a matrix, symmetric and skew symmetric matrices. Addition, multiplication and scalar multiplication of matrices, simple properties of addition, multiplication and scalar multiplication. Non-commutativity of multiplication of matrices and existence of non-zero matrices whose product is the zero matrix (restrict to square matrices of order 2). Concept of elementary row and column operations. Invertible matrices and proof of the uniqueness of inverse, if it exists; (Here all matrices will have real entries). Determinant of a square matrix (up to 3×3 matrices), properties of determinants, minors, cofactors and applications of determinants in finding the area of a triangle. Adjoint and inverse of a square matrix. Consistency, inconsistency and number of solutions of system of linear equations by examples, solving system of linear equations in two or three variables (having unique solution) using inverse of a matrix.

Unit 4: Mathematical Reasoning and Linear Programming

Mathematically acceptable statements, Connecting words/phrases-consolidating the understanding of “if and only if (necessary and sufficient) condition”, “implies”, “and/or”, “implied by”, “and”, “or”, “there exists” and their use through variety of examples related to real

life and Mathematics. Validating the statements involving the connecting words-difference between contradiction, converse and contrapositive.

Introduction, related terminology such as constraints, objective function, optimization, different types of linear programming (L.P.) problems, mathematical formulation of L.P. problems, graphical method of solution for problems in two variables, feasible and infeasible regions, feasible and infeasible solutions, optimal feasible solutions (up to three non-trivial constrains).

B.A./B.Sc. (Hons.) V Semester
Mathematics
Course Title: Real Analysis I
Course Number: MMB-551
Credits: 04

Unit – I: Elements of Point Set Theory on R (14 LECTURES)
Sets, Intervals: Open and closed, Bounded and unbounded sets: Supremum and infimum, Neighbourhood of a point, interior points, Open sets and results, Limits points of a set, Bolzano – Weierstrass Theorem, Closed sets and related results, Countable and uncountable sets, Compact sets and related results.

Unit – II: Limits and Continuity of Functions on R (14 LECTURES)
Limit of a function, Theorems on algebra of limits, Sequential approach, Cauchy's criteria for finite limits, Continuous functions, Discontinuous functions, Theorems on continuity, Properties of continuous functions on closed intervals, Uniform continuous functions and related results.

Unit – III: Differentiation of Functions on R (14 LECTURES)
Definitions of derivatives and related results, Increasing and decreasing functions, Darboux's theorem, Rolle's theorem, mean value theorems of differential calculus and their applications, Taylor's theorem with various forms of remainder, Maculaurin's theorem, Taylor's infinite series, Maculaurin's infinite series expansion of some functions.

Unit – IV: Functions of Bounded Variations (14 LECTURES)
Functions of bounded variations and their properties, Variation function and related results, Jordon theorem, Vector valued functions, Vector valued functions of bounded variation and related results.

BOOKS RECOMMEND:

1. W. Rudin: Principles of Mathematical Analysis, Third Edition, McGraw Hill, New York 1976.
2. S.C. Malik and Savita Arora: Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International (P) Limited, New Delhi, 1994.

B.A./B.Sc. (Hons.) V Semester
Mathematics
Course Title: Group Theory
Course Number: MMB-552
Credits: 04

Unit – I

Binary relation, Function, Binary Operation, Groups, Various properties and examples of group, Subgroups, Properties of subgroups, Normal subgroups and important results, Cyclic groups, generator, Properties of Cyclic groups.

Unit – II

Cosets, Lagrange's theorem, Euler theorem, Fermat's theorem (with proofs), Isomorphism and homomorphism of groups and their examples and results, Quotient group.

Unit – III

First, Second and Third Isomorphism Theorems (with proofs), Direct product of groups and its related results.

Unit – IV

Permutations, even and odd permutations, transportation, disjoint cycles, permutation groups and its related results, Cayley's theorem, Cauchy's theorem (with proofs).

Text Book:

N.S. Gopalakrishnan: University Algebra.

Reference Book:

Contemporary Abstract Algebra by Joseph A. Gallian.

B.A./B.Sc. (Hons.) V Semester
Mathematics
Course Title: Set Theory and Number Theory
Course Number:-553
Credits: 04

Unit–I Sets, logical connectives and quantifiers, Cartesian product of sets, Equivalence relation and partition, Fundamental theorem of equivalence relation, functions, their restrictions and extensions, characteristic functions and choice functions, Equivalent sets, Infinite sets.

Unit–II Denumerable sets, Countable sets, The continuum, Cardinals, Cardinal arithmetic, Inequalities and cardinal numbers, Cantor's theorem

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Unit–III Schroeder Bernstein theorem, Continuum hypothesis, partially ordered sets, Totally ordered sets, First and last elements, Maximal and minimal elements, Upper and lower bounds, Similar sets and ordered types, well-ordered sets.

Unit–IV Transfinite induction, Limit elements, Initial segments, Similarity between well ordered sets and their subsets, Ordinal numbers and their inequalities, Addition and multiplication of ordinals, Distributive laws, Structure of ordinal numbers, Axiom of choice, Zorn's lemma and well ordering principle.

BOOKS RECOMMEND:

1. Seymour Lipschutz: Set Theory and Related Topics. (Schuam's Outline Series)
2. P.R. Halmos: Naive Set Theory

B.A./B.Sc. (Hons.) V Semester
Mathematics
Course Title: Curves and Surfaces
Course Number: MMB-554
Credits: 04

Unit- I: Space Curves (10 Lectures)

Space curves. Examples. Plane curves. Parameterization of curves (Generalized and natural parameters) Change of parameter regular curves and singularities. Contact of curves. Contact of a curve and a plane. Frenet trihedron. Osculating plane. Serret-Fernet formulae. Involutes and Evaluates, Fundamental Theorem for space curves.

Unit- II: Surface in R^3 (10 Lectures)

Surface in R^3. Implicit and explicit forms of the equation of a surface. Parametric curves on surfaces. Tangent plane. First fundamental form. Angle between two curves on a surface. Area of a surface. Invariance under co-ordinate transformation.

Unit- III: EXTRINSIC GEOMETRY (10 Lectures)

Second fundamental form on a surface, Gauss map and Gaussian curvature. Gauss and Weingrten formulae. Christoffle symbols. Some co-ordinate transformations. Goddazi equation and Gauss theorem. Fundamental Theorem of surface Theory.

Unit- IV: CURVES ON A SURFACE (10 Lectures)

Curvature of a curve on a surface. Geodesic curvature and normal curvature. Geodesics. Principal directions and lines of curvature. Rodrigue formula. Asymptotes Lines. Conjugate Directions. Developable surfaces.

Books Recommend:

1. A**.** Goetz: Differential Geometry, Springer Verlag.
2. S.I. Husain: Lecture notes on Differential Geometry.

B.A./B.Sc. (Hons.) V Semester
Mathematics
Course Title: Mechanics
Course Number: MMB-555
Credits: 04

Unit – I

Vector moment of a force, Varignon's Theorem on moments, Resultant of a couple, Resultant of coplanar forces, Equation of line of action of the resultant. Equilibrium of a rigid body, Conditions of equilibrium of three force body. Cables, Suspension and parabolic cables, Intrinsic and Cartesian equation of a catenary, Sag and span, maximum tension in a cable.

Unit – II

Virtual work. Principle of virtual work. Determination of tension in a string and thrust in a rod. Solutions of problems involving equilibrium by principle of virtual work. Centre of gravity. Determination of centre of gravity by integration. Centre of gravity of arcs, plane areas, enclosed areas, solids of revolution and surfaces of revolution.

Unit – III

Kinematics and kinetics, Tangential, normal, radial and transverse components of velocity and acceleration. Motion of projectile without resistance. Projectile motion up and down an inclined plane. Tangent problems. Motion in a resisting medium including projectiles. Upward and downward motion in a resisting medium.

Unit – IV

Motion of particles in central orbits. Stability of circular orbits. Kepler's laws of planetary motion. Plane impulsive motion. Direct and oblique impact. Loss of energy during impact. Impact against a fixed plane. Simple harmonic motion. Motion of a simple pendulum.

Books recommended:

1. J.L. Synge and G.B. Griffith: Principle of Mechanics
1. M.A. Pathan: Statics

Reference books:

1. Jhonson and Beer: Vector Mechanics for Engineers
2. Zafar Ahsan: Lectures Notes on Mechanics

Mathematics (Optional)
Course Title: Tensor Analysis
Course Number:-556
Credits: 04

Unit-1: **Lecture 10**

Dummy indices, free indices, summation convention, KRONECKER symbols, permutation symbols, differentiation of a determinant, linear equations, Cramer's Rule, functional determinants, functional matrices, quadratic forms, real quadratic forms, pairs of quadratic forms, quadratic differential forms, differential equations, Space of N-dimensions, subspaces, directions at a point.

Unit-2: **Lecture 10**

Transformations of coordinates, contravariant vectors, scalar invariants, covariant vectors, scalar product of two vectors, tensors of the second order, tensors of any order, symmetric and skew symmetric tensors, Addition and multiplication of tensors, contraction, composition of tensors, quotient law, reciprocal symmetric tensors of the second order.

Unit-3: **Lecture 12**

Riemannian space, Fundamental tensor, length of a curve, magnitude of a vector, associate covariant and contravariant vectors, inclination of two vectors, orthogonal vectors, coordinate hypersurfaces, coordinate curves, field of normals to a hypersurface, N-ply orthogonal system of hypersurfaces, congruences of curves, orthogonal ennuples, principal directions for a symmetric covariant tensor of the second order, Euclidean space of n-dimensions.

Unit-4: **Lecture 18**

The Christoffel symbols and their properties, second order derivatives of the metric tensors, Covaraint derivative of a covariant vector, curl of a vector, covariant derivative of a contravariant vector, derived vector in a given direction, covariant differentiation of tensors, covariant differentiation of sums and products, divergence of a vector, Laplacian of a scalar invariant, Intrinsic derivatives, Curvature tensor, Ricci tensor, scalar curvature, covariant curvature tensor, Bianchi Identities.

Text Book:

1. Riemannian geometry and The Tensor Calculus by C. E. Weatherburn, CUP, 1938.

Reference Books:

1. Tensor Analysis: Theory and Applications by I. S. Sokolnikoff, Chapman and Hall, 1951.
2. Tensor Calculus by U. C. De, A. A. Shaikh and J. Sengupta, Narosa Publi. , New Delhi, 2nd Edition, 2008.
3. Tensors-Mathematics of Differential Geometry and relativity by Zafar Ahsan, PHI, New Delhi, 2015.

B.A./B.Sc.(Hons.) V Semester
Mathematics
Course Title: Integral Equations
Course Number: MMB 557
Credit: 04

Unit –I

Linear integral equations of the first and second kind. Volterra and Fredholm integral equations. Relation between differential and integral equations Solution of Volterra and Fredholm integral equations by the method of successive substitutions and successive approximations.

Unit-2

Iterated and resolvent kernels. Neumann series reciprocal functions.Volterra solution of Fredholm equations. Fredhlom theorem. Fredholm associated equation.

Unit -3

Solution of integral equations using Fredholm's determinant and minor. Homogeneous integral equations. Integral equations with separable kernels. The Fredholm alternatives. Symmetric kernels.

Unit-4

Fundamental theorems on symmetric equations. Hilbert Schmidt Theory for symmetric kernels. Solution of symmetric integral equations.

BOOK RECOMMEND:

1-Shanti Swarup: Integral Equations Krishna Media (P)Ltd . Meerut, 1982
2-W.V.Lovitt:Linear integral Equation, Dover Publications Inc. New York,1950
3-K.F. Riley, M.P. Hobson and S.T. Bence: Mathematical Methods for Physics and Engineering , Cambridge University Press, U.K. 1977.

B.A./B.Sc. (Hons.) VI Semester
Mathematics
Course Title: Real Analysis II
Course Number: MMB651
Credits: 04

Unit – I: Real Sequence (14 LECTURES)

Concept of sequence, Limit points of a sequence, Limit inferior and superior, Convergent and divergent sequences with related theorems; Cauchy's general principle of convergence, Algebra of sequence and statement of related theorems with applications, Monotonic increasing and decreasing sequences, Several examples on this unit with solutions.

Unit–II: Real Sequence (14 LECTURES)

Introduction of infinite series, Sequence of partial sums and convergence of infinite series, Necessary condition for the convergence of an infinite series with proof, Positive term series, Comparison tests (first type and limit form), Cauchy root test, D'Alembert's ratio test with their applications, Alternating series, Leibnitz test, Absolute and conditional convergence, Series of arbitrary terms, Abel's and Dirichlet's tests.

Unit – III: Riemann Integration (14 LECTURES)

Definition and existence of Riemann integral; Inequalities for Riemann integrals; Refinement of partitions; Darboux's theorem'; Theorems on conditions of integrability; Theorems on integrability of the sum, difference, quotient and product of integrable functions (without proof), Theorems on integrability of the modulus and square of integrable functions, The Riemann integral as a limit of sums, Theorems on integrable functions, The fundamental theorem: First and generalized first mean value; Theorems of integral calculus, Integartion by parts, Change of variables, Second mean value theorem.

Unit –IV: Riemann Stieltjes Integration and Fourier Series (14 LECTURES)

Definition and existence of the integral, refinement of partitions, Condition of integrability and related results, Integral as a limit of sums and related results; Fourier series; Bessel's inequality; Dirichlet's criteria of convergence of Fourier series; Fourier series for even and odd functions; Fourier series on $[0,2\pi]$, $[-l,l]$ and $[0,l]$, where 1 is a real number.

BOOKS RECOMMEND:

1. W. Rudin: Principles of Mathematical Analysis, Third Edition, McGraw Hill, New York, 1976.
2. S.C. Malik and Savita Arora: Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International (P) Limited, New Delhi, 1994.

B.A./B.Sc. (Hons.) VI Semester
Mathematics
Course Title: Ring Theory
Course Number: MMB652
Credits: 04

Unit – I

Rings, Zero divisors, Integral domains, Division Rings, Field, Subrings and Ideals, Congruence modulo a subring relation in a ring, Simple ring, Algebra of ideals, Ideal generated by a subset, Nilpotent ideals, Nil ideals, Quotient rings, Prime and Maximal ideals.

Unit – II

Homomorphism in rings, Natural homomorphism, Kernel of a homomorphism, Fundamental theorem of homomorphism, First and second isomorphism theorems, Field of quotients, Embedding of rings, Ring of endomorphisms of an abelian group.

Unit – III

Factorization in integral domains, Prime and irreducible elements, H.C.F. and L.C.M. of two elements of a ring. Principal ideals domains, Euclidean domains, Unique factorisation domains, Different relations between principal ideal domains, Euclidean domains and unique and unique factorization domains.

Unit – IV

Polynomials rings, Algebraic and transcendental elements over a ring, Factorization in polynomial ring R[x]. Division algorithm in R[x] where R is a commutative rings with identity, Properties of polynomial ring R[x] if R is a field or a U.F.D., Gauss lemma, Gauss Theorem (statement only), Eisenstein irreducibility criteria and its applications, Division algorithm for polynomial ring F[x], where F is a field, Reducibility test for polynomials of degree 2 and 3 in F[x].

BOOKS RECOMMEND:

1. Surjeet Singh, Quazi Zameeruddin: Modern Algebra

BOOKS FOR REFERENCE:

1. J.B. Fraleigh: A first Course in Abstract Algebra.
2. Joseph A Gallian: Contemporary Abstract Algebra.

B.A./B.Sc. (Hons.) VI Semester
Mathematics
Course Title: Metric Spaces
Course Number: MMB653
Credits: 04

Unit –I (10 Lectures)

Definition and examples of metric spaces; Statements of inequalities of Holder and Minkowski; Properties of metrics; Bounded and unbounded metric spaces; Distance between sets and diameter of a set; Open sets and interior points; Limit points, closed sets and closure of sets; Exterior points, boundary points, boundary of a set; Subspaces.

Unit –II (12 Lectures)

Convergent and Cauchy sequences in metric spaces; Complete metric spaces; Cantor's intersection theorem; Completion of a metric space; Basis of a metric space; First and second countable metric spaces; Dense sets; Separable metric spaces and examples; Nowhere dense sets; Baire's category theorem.

Unit –III (10 Lectures)

Open cover; Compact metric spaces; Finite Intersection property; Sequentially compact spaces; Wolzano-Weierstrass property; ε-net and totally bounded spaces; Lebesgue's covering lemma

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Unit –IV (10 Lectures)

Continuous function between two metric spaces and its characterizations; Continuous functions and compact spaces; Uniform continuous functions; Homeomorphism and equivalent metrics; Uniform convergence sequences of functions; Cauchy Criterion for uniform convergence.

BOOKS RECOMMENDED:

1. Q.H. Ansari: Metric Spaces, Including Fixed Point Theory and Set-valued Maps, Narosa Publishing House, New Delhi 2010, Chapters 1 – 5.

B.A./B.Sc. (Hons.) V Semester
Mathematics
Course Title: Complex Analysis
Course Number: MMB-654
Credits: 04

Unit-I Revision of basic concepts; Triangle inequality; Roots of complex numbers; Region in the complex plane; Functions of a complex variable; Theorems on Limits; Limits involving the point at infinity; Continuity; Derivatives; Examples.

Unit-II Cauchy-Riemann (CR) equations; Sufficient conditions for the differentiability; Polar form of CR equations; Analytic functions; Harmonic functions; Harmonic conjugate; Polar form of Laplace equation; Complex valued functions; Complex line integrals/contour integrals; Examples.

Unit-III Cauchy-Goursat theorem (without proof); Consequences of Cauchy-Goursat theorem; Cauchy's integral formula; Cauchy's integral formula for higher order derivatives; Morera's theorem; Cauchy's inequality; Liouville's theorem; Fundamental theorem of algebra; Gauss' mean value theorem; Maximum and minimum modulus theorems/principles; Examples.

Unit-IV Power series; Taylor's series; Laurent's series; Singular points; Classifications of singularities; Zeros and poles of order m; Residues; Calculation of residues; Residue theorem; Evaluation of integrals; Examples.

Recommended Book:

1. Ruel V. Churchill and James W. Brown: Complex Variables& Applications. New York McGraw Hill, 4th Edition, 1984.

Reference Book:

1. Murray R. Spiegel: Schaum's Outline Series: Theory and Problems of Complex Variables.

(OPTIONAL)
B.A./B.Sc. (Hons.) VI Semester
Mathematics
Course Title: Introduction to Matlab & its Applications
Course Number: MMB-655
Credits: 04

Unit – I (14 Lectures)

Introduction to Matlab, Standard Matlab windows (Command Window, Figure Window, Editor Window, help window), The semicolon(;), The clc command, Using Matlab as calculator, Display formats, Elementary math built in functions, Defining scalar variables, Examples of Matlab applications, Creating arrays (one dimensional & two dimensional), The zeroes, ones and eye commands, The transpose operators, Using a colon, Adding elements to existing variables, Deleting elements, Built in functions for handling arrays.

Unit – II (14 Lectures)

Array multiplication, Inverse of a matrix, Solving three linear equations (array division), element by element operations, Built in function for analysing arrays, Generation of random numbers, Creating and saving a script files, output commands.

Unit – III (14 LECTURES)

The plot command, Plot of a function, Plotting multiple graph in the same plot, Using the hold on, hold off commands, Function and Function files (basic), Conditional statements, Loops, Nested loops and nested conditional statements, Calculating polynomials with Matlab (Problems based on roots & derivatives of polynomials).

Unit – IV (14 LECTURES)

Line plots, Mesh and surface plots, plots with special graphics, The view commands, Solving an equation in one variable, solving a nonlinear equation, finding a minimum or maximum of a function, Numerical integration, Solving ordinary differential equations.

BOOKS RECOMMEND:

1. Amos Gilat: Matlab: An Introduction and its Applications, Wiley India Edition.

(Optional)
B.Sc. (Hons.) VI Semester
Mathematics
Course Title: Optimization
Course No: MMB-656
Credits: 04

UNIT-1

Definitions and scope of O.R.(see Ch-1 in [1]), Linear programming problem (Sec:2.2 in [1]), Formulation of linear programming problem (Sec:2.3, 2.4 in [1]), Graphical solution of L.P.P. (Sec:3.2 in [1]), Some exceptional cases (Sec:3.3 in [1]), General L.P.P. and some definitions (Sec:3.4 in [1]), Canonical and standard form of L.P.P. (Sec:3.5 in [1]).

UNIT-2

Hyperplane, Convex sets and their properties (Sec:0.13 in [1]), Some definitions (Sec:4.1 in [1]), Fundamental theorem of linear programming (Theo 4.3 in [1]), Simplex method (Sec:4.3 in [1]), Two-phase method, Big M method (Sec:4.4 in [1]), Duality in L.P.P., General Primal-Dual pair (Sec:5.2, 5.4 in [1]), Weak duality theorem, Strong duality theorem (Sec:5.5 in[1]), Dual simplex method (Sec:5.7 in [1]).

UNIT-3

Convex functions and their properties (Sec:7.2 in [2]), General NLPP (Sec: 27.3 in [1]), Formulation of NLPP (Sec: 27.2 in [1]), Methods for solving NLPP: Graphical method (Sec:28.2 in [1]), Method of Lagrange's multipliers (Sec:27.4 in [1]), The Steepest Descent method (unconstrained opt. prob.) (Sec:9.4 in [2]), Newton's method (unconstrained opt. prob.) (Sec:9.5 in [2]).

UNIT-4

KKT necessary/sufficient optimality conditions, Solution of NLPP using KKT conditions (Sec:27.5 in [1], Sec: 8.5 in [2]), Quadratic programming (Sec:28.4 in [1]), Wolfe's method for quadratic programming (Sec: 28.5 in [1], Sec:7.7 in [2]), Convex programming problems (Sec:7.4 in [2]).

Text Book:

1. Kanti Swarup, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand & Sons, 2009.

Books Recommended:

2. S. Chandra, Jayadeva, Aparna Mehra, Numerical Optimization with Applications, Narosa.
3. Hamdy A. Taha, Operations Research, An Introduction, 9th Edition, Pearson.
4. M.S. Bazarra, H.D. Sheral and C.M. Shetty, Nonlinear Programming theory and Algorithms, John Wiley and Sons, Inc.

(Optional)
B.Sc. (Hons.) VI Semester
Mathematics
Course Title: Discrete Mathematics
Course No: MMB-657
Credits: 04

Unit 1:

Propositional Logic: Propositional Logic, Applications of Propositional Logic, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference, Introduction to Proofs, Proof Methods and Strategies.

Unit 2:

Graphs and Graph Models: Graph Terminology and Special Types of Graphs, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs.

Unit 3:

Trees: Introduction to Trees, Applications of Trees, Tree Traversal, Spanning Trees, Minimum Spanning Trees. Boolean Algebra: Boolean Functions, Representing Boolean Functions, Logic Gates, Minimization of Circuits

Unit 4:

Coding Theory: Introduction to coding theory, Error Correction, Group codes, Weight of codes word, Distance between the code word, Parity-check and generator matrix, Linear codes and cyclic codes.

Books:

1. Rosen, K. H. (2007), Discrete Mathematics and Its Applications, 7^{th} edition, USA, McGraw-Hill.
2. W. B. West , Introduction to Graph Theory, Prearson Education (Singapore) .
3. Ling, S. and Xing, C. P. (2004), Coding Theory: A First Course, Cambridge University Press, Cambridge.