

COURSE STRUCTURE

FOR

UNDERGRADUATE COURSE IN MATHEMATICS

HONOURS AND PASS (GENERAL)

COURSE CONTENT

HONOURS COURSE

Paper Code	Course Code	Title of the paper	Total Credit
C-1	MAT/H/C1	Calculus	6
C-2	MAT/H/C2	Algebra	6
C-3	MAT/H/C3	Real Analysis	6
C-4	MAT/H/C4	Ordinary Differential Equations	6
C-5	MAT/H/C5	Theory of Real Functions	6
C-6	MAT/H/C6	Group Theory	6
C-7	MAT/H/C7	PDE and Systems of ODE	6
C-8	MAT/H/C8	Numerical Methods	6
C-9	MAT/H/C9	Riemann Integration and Series of Functions	6
C-10	MAT/H/C10	Ring Theory and Linear Algebra-I	6
C-11	MAT/H/C11	Multivariate Calculus	6
C-12	MAT/H/C12	Mechanics-I	6
C-13	MAT/H/C13	Metric Spaces and Complex Analysis	6
C-14	MAT/H/C14	Higher Trigonometry and Linear Algebra-II	6

GENERIC ELECTIVE PAPERS (6 Credit Each)

Paper Code	Course Code	Title of the paper	Total Credit
GE-1	MAT/H/GE1	Calculus	6
GE-2	MAT/H/GE2	Ordinary Differential Equations	6
GE-3	MAT/H/GE3	PDE and Systems of ODE	6
GE-4	MAT/H/GE4	Numerical Methods	6

DISCIPLINE SPECIFIC ELECTIVE (6 Credit Each)

Paper Code	Course Code	Title of the paper	Total Credit
DSE-1	1. MAT/H/DSE1A 2. MAT/H/DSE1B	1. Elementary Number Theory 2. Analytic Geometry	6
DSE-2	1. MAT/H/DSE2A 2. MAT/H/DSE2B	1. Boolean Algebra and Automata Theory 2. Probability and Statistics-I	6
DSE-3	1. MAT/H/DSE3A 2. MAT/H/DSE3B	1. Theory of Equations 2. Linear Programming	6
DSE-4	1. MAT/H/DSE4A 2. MAT/H/DSE4B	1. Mechanics-II 2. Differential Geometry	6

SKILL ENHANCEMENT COURSES (2 Credit Each)

Paper Code	Course Code	Title of the paper	Total Credit
SEC-1	1. MAT/H/SEC1A 2. MAT/H/SEC1B	1. Logic and Sets 2. Computer Graphics	2
SEC-2	1. MAT/H/SEC2A 2. MAT/H/SEC2B	1. Graph Theory 2. Operating System: Linux	2

PASS COURSE

For Pass Course in Mathematics, a student may take any combination of subjects with Mathematics.

Core papers (4 papers for each discipline)

Paper Code	Course Code	Title of the paper	Total Credit
DSC-1A	MAT/P/DSC1A	Calculus	6
DSC -1B	MAT/P/DSC1B	Ordinary Differential Equations	6
DSC-1C	MAT/P/DSC1C	PDE and Systems of ODE	6
DSC-1D	MAT/P/DSC1D	Numerical Methods	6

SKILL ENHANCEMENT COURSES (2 Credit Each)

Paper Code	Course Code	Title of the paper	Total Credit
SEC-1	1. MAT/P/SEC1A 2. MAT/P/SEC1B	1. Logic and Sets 2. Computer Graphics	2
SEC-2	1. MAT/P/SEC2A 2. MAT/P/SEC2B	1. Graph Theory 2. Linear Algebra-III	2
SEC-3	1. MAT/P/SEC3A 2. MAT/P/SEC3B	1. Probability and Statistics-II 2. Basic Mechanics-I	2
SEC-4	1. MAT/P/SEC4A 2. MAT/P/SEC4B	1. Basic Mechanics-II 2. Complex Analysis	2

DISCIPLINE SPECIFIC ELECTIVE (6 Credit Each)

Paper Code	Course Code	Title of the paper	Total Credit
DSE-1	1. MAT/P/DSE1A 2. MAT/P/DSE1B	1. Elementary Number Theory 2. Analytic Geometry	6
DSE-2	1. MAT/P/DSE2A 2. MAT/P/DSE2B	1. Theory of Equations 2. Linear Programming	6

Honours Course Syllabus

MAT/H/C1: Calculus

UNIT 1

Real variables. Continuous and discrete. Interval. Function. Domain of definition. Monotone functions. Inverse functions. Geometrical representations. Limit of a function on the real line. One-sided limits - right hand and left hand limits. Different types of limits. Theorems on limits.

UNIT 2

Continuous functions. Definitions. Discontinuity. Theorems and properties on continuity of functions. Uniform continuity.

UNIT 3

Derivatives. Definition. Theorems on derivatives. Continuity of a derivable function. Algebraic and transcendental functions. General rules of differentiation. Function of a function. Chain rule. Inverse function. Logarithmic differentiation. Implicit functions. Parametric equations.

UNIT 4

Derivative of a rate measure. Time rate of change. Rectilinear motion. Related rates. Geometric interpretation. Meaning of the sign of the derivative. Determination of multiple roots. Basic methods of integration. Integration by substitution. Integrations by parts. Integration of trigonometric and hyperbolic functions. Rational function of sine and cosine.

Books Recommended

1. H. Anton, I. Bivens, S. Davis – Calculus, Wiley.
2. J. Hass, C. Heil, M. Weir – Thomas' Calculus, Pearson.
3. T.M. Apostol – Calculus Volume I, Wiley.
4. T.M. Apostol – Calculus Volume II, Wiley.

MAT/H/C2: Algebra

UNIT 1

Equivalence relations, Functions, Composition of functions, Invertible of Functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm. Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

UNIT 2

Matrix. Rows and columns. Determinant and trace. Properties of determinant. Eigen values and eigen vectors and their relation with determinant and trace of a matrix. Determinant of inverse of an invertible matrix and corresponding eigen vectors. Cayley-Hamilton Theorem.

UNIT 3

Types of matrices: Symmetric, Hermitian, skew-symmetric, skew-Hermitian, orthogonal, unitary, positive and negative definite, positive and negative semidefinite. Properties of the rows, columns, eigen values and eigen vectors of these matrices. Diagonalizability of matrix. Eigen value decomposition of matrix.

UNIT 4

Systems of linear equations, coefficient matrix and augmented matrix, row reduction and echelon forms, vector equations, the matrix equation $Ax=b$, solution of system of linear equations. Consistent and inconsistent system of linear equations.

Books recommended

1. S. Kumaresan - Linear Algebra: A Geometric Approach, Prentice Hall.
2. M.K. Sen and S. Ghosh - Topics in Abstract Algebra, Universities Press.
3. David C. Lay - Linear Algebra and its Applications, Pearson.
4. R.A. Horn – Matrix Analysis, Cambridge University Press.

MAT/H/C3: Real Analysis

UNIT 1

Review of Algebraic and Order Properties of \mathbb{R} , ε - neighbourhood of a point in \mathbb{R} , Idea of countable sets, uncountable sets and uncountability of \mathbb{R} . Bounded above sets, Bounded below sets, Bounded sets, Unbounded sets, Suprema and Infima, The Completeness Property of \mathbb{R} , The Archimedean Property, Density of Rational (and Irrational) numbers in \mathbb{R} .

UNIT 2

Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano - Weierstrass theorem for sets. Open and closed sets. Compact sets. Heine - Borel theorem.

UNIT 3

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence, Theorems on limits, Monotone Sequences, Monotone Convergence Theorem. Subsequence, Divergence Criteria, Monotone Subsequence Theorem (statement only). Bolzano - Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy Convergence Criterion.

UNIT 4

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

Books recommended

1. R.G. Bartle and D.R. Sherbert - Introduction to Real Analysis, Wiley
2. A. Kumar and S. Kumaresan - A Basic Course in Real Analysis, CRC Press.
3. W. Rudin - Principles of Mathematical Analysis, McGraw Hill Education.

MAT/H/C4: Ordinary Differential Equations

UNIT 1

Differential equations. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form.

UNIT 2

Differential equations of the first order and first degree - Equation reducible to homogenous form. Bernoulli's equation. Exact differential equations. Differential equation of the first order but not of the first degree. Equations solvable for p , x , y . General and singular solutions. Clairaut's equation. Linear differential equations of higher order with constant coefficients. Complementary function and particular integrals.

UNIT 3

General solutions of homogenous equation of second order, principle of super position for homogenous equation, Wronskian: its properties and applications. Linear homogenous and non - homogenous equations of higher order with constant coefficients.

UNIT 4

Linear equation of second order. Standard form. Complete solution. Complementary function. Particular integral. Reduction to normal form. Transformation by changing the independent variable. Method of variation of parameters. Solution by operators. Simultaneous equations of the form $dx/P = dy/Q = dz/R$. Solution. Geometrical interpretation. Total differential equations. Solution by inspection.

Books Recommended

1. G.F. Simmons – Differential Equations with Applications and Historical Notes, CRC Press.
2. S.L. Ross -- Differential Equations, Wiley.
3. B. Barnes, G.R. Fulford -- Mathematical Modeling with Case studies: A Differential Equation Approach using Maple and Matlab, CRC Press/ Chapman and Hall.
4. C.H. Edwards, D.E. Penny, D. Calvis -- Differential Equations and Boundary Value Problems: Computing and Modeling, Pearson.

MAT/H/C5: Theory of Real Functions

UNIT 1

Limits of functions (approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous fractions.

UNIT 2

Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non - uniform continuity criteria, uniform continuity theorem.

UNIT 3

Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum. Rolle's theorem, Mean value theorem, intermediate value property of derivatives.

UNIT 4

Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials, Taylor's theorem to inequalities . Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder.

Books Recommended

1. R. Bartle, D.R. Sherbert -- Introduction to Real Analysis, Wiley.
2. K.A. Ross -- Elementary Analysis: The Theory of Calculus, Springer.
3. A. Mattuck -- Introduction to Analysis, Prentice Hall.
4. S.R. Ghorpade, B.V. Limaye -- A Course in Calculus and Real Analysis, Springer.

MAT/H/C6: Group Theory

UNIT 1

Group. Definition. Examples. Abelian Group. Order of a group (types of group). Elementary properties of groups using definition. Integral power of an element of a group.

UNIT 2

Subgroups and examples of subgroups, Cosets, properties of cosets. Normal subgroups. Cyclic group, centralizer, normalizer, centre of a group, product of two subgroups. Properties of cyclic groups, classification of subgroups of cyclic groups.

UNIT 3

Permutations. Symmetric groups and permutation groups. Cyclic notation for permutations, properties of permutations, even and odd permutations, alternating group. Lagrange's theorem and consequences including Fermat's Little theorem. Normal subgroups, factor groups.

UNIT 4

Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems. Cauchy's theorem for finite abelian groups.

Books Recommended

1. J.B. Fraleigh -- A First Course in Abstract Algebra, Pearson.
2. M. Artin -- Abstract Algebra, Pearson.
3. I.N. Herstein -- Topics in Algebra, Wiley.

MAT/H/C7: PDE and Systems of ODE

UNIT 1

Partial Differential Equations - Basic concepts and Definitions, Mathematical Problems. First - Order Equations: Classifications, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solutions of Quasi Linear Equations.

UNIT 2

Canonical Forms of First - order Linear Equations. Method of Separation of Variables for solving first order partial differential equations. Wave equation and Laplace equation. Classification of second order Linear Equations to canonical forms.

UNIT 3

The Cauchy Problem of an infinite string . Initial Boundary Value Problems, Semi - Infinite String with a fixed end, Semi - Infinite String with a Free end, Equations with non - homogenous boundary conditions.

UNIT 4

Non - Homogenous Wave Equation. Method of separation of variables. Solving the Vibrating String Problem. Solving the Heat Conduction problem. Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients. Basic Theory of linear systems in normal form, homogenous linear systems with constant coefficients: Two Equations in two unknown functions.

Books Recommended

1. T. Myint-U, L. Debnath -- Linear Partial Differential Equations for Scientists and Engineers, Birkhäuser.
2. S.L. Ross -- Differential Equations, Wiley.
3. M.L. Abell, J.P. Braselton -- Differential equations with MATHEMATICA, Elsevier Academic Press.

MAT/H/C8: Numerical Methods

Use of Scientific Calculator is allowed.

UNIT 1

Finite differences. The operators Δ , ∇ and E . Properties. Central difference operators μ and δ . Gauss's central difference formula.

UNIT 2

Transcendental and Polynomial equations. Bisection method, Newton's method. Secant method. Rate of convergence of these methods.

UNIT 3

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

UNIT 4

Interpolation. Lagrange and Newton's methods. Error bounds. Gregory forward and backward difference interpolation. Numerical Integration: Trapezoidal rule, Simpson's $3/8^{\text{th}}$ rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule.

Books Recommended

1. B. Bradie -- A Friendly Introduction to Numerical Analysis, Pearson.
2. M.K. Jain, S.R.K. Iyengar, R.K. Jain -- Numerical Methods for Scientific and Engineering Computation, New age International Publisher.
3. J.B. Scarborough – Numerical Mathematical Analysis, Oxford and IBH Publishers.
4. S.S. Sastry – Introductory Methods of Numerical Analysis, Prentice Hall India.

MAT/H/C9: Riemann Integration and Series of Functions

UNIT 1

Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions.

UNIT 2

Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus. Integration by parts.

UNIT 3

Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions.

UNIT 4

Series of functions; Theorems on the continuity and derivability of the sum function of a series of a functions; Cauchy criterion for uniform convergence and Weierstrass M -Test. Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem. Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.

Books Recommended

1. K.A. Ross -- Elementary Analysis: The Theory of Calculus, UTM, Springer.
2. R.G. Bartle, D.R. Sherbert -- Introduction to Real Analysis, Wiley.
3. T.M. Apostol -- Mathematical Analysis, Narosa.
4. W. Rudin – Principles of Mathematical Analysis, McGraw Hill Education.
5. A. Kumar, S. Kumaresan – A Basic Course in Real Analysis, CRC Press.

MAT/H/C10: Ring Theory and Linear Algebra-I

UNIT 1

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

UNIT 2

Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I,II and III, field of quotients.

UNIT 3

Rank. Row and Column rank. Linear equations. Solution of system of linear equations. Homogenous and non-homogenous. Coefficient matrix. Augmented matrix. Echleon form. Normal form. Vector spaces, subspaces, algebra of subspaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

UNIT 4

Linear transformations, null space, range, rank and nullity of a linear transformation, rank-nullity theorem, matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms, Isomorphism theorems, invertibility and isomorphisms. Characteristic vector and root. Characteristic polynomial. Eigen space. Algebraic and geometric multiplicities. Minimal Polynomial. Cayley-Hamilton theorem.

Books Recommended

1. I.N. Herstein -- Topics in Algebra, Wiley.
2. J.A. Gallian -- Contemporary Abstract Algebra, Cengage Learning.
2. S. Kumaresan -- Linear Algebra: A Geometric Approach, Prentice Hall of India.
3. K. Hoffman, R. Kunze-- Linear Algebra, Pearson.

MAT/H/C11: Multivariate Calculus

UNIT 1

Linear transformations. Functions of several variables, limit and continuity of functions of several variables. Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient.

UNIT 2

Mean value theorem, Inverse function theorem, Implicit Function theorem for several variables. Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems. Definition of vector field, divergence and curl.

UNIT 3

Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals.

UNIT 4

Change of variables in double integrals and triple integrals. Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path. Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem. The Divergence theorem.

Books Recommended

1. G.B. Thomas, R.L. Finney -- Calculus, Pearson.
2. M.J. Strauss, G.L. Bradley, K.J. Smith -- Calculus, Pearson.
3. E. Marsden, A.J. Tromba, A. Weinstein -- Basic Multivariable Calculus, Springer-Verlag.
4. T.M. Apostol -- Calculus Volume 2, Wiley.
5. T.M. Apostol -- Mathematical Analysis, Narosa.

MAT/H/C12: Mechanics-I

UNIT 1

Coplanar forces. Moment of a system of coplanar forces. Equation of line of action of the resultant of a system of coplanar forces. Necessary and sufficient condition for the equilibrium of a system of coplanar forces acting on a rigid body. Astatic equilibrium. Equilibrium of a rigid body under three forces. (m,n) theorem.

UNIT 2

Work. Work done by a system of concurrent forces. Virtual work. Principle of virtual work for a system of coplanar forces acting on a particle. Omission of forces. Stability of equilibrium. Stable, unstable and neutral equilibrium. Work function test for the nature of stability of equilibrium. Energy test for equilibrium.

UNIT 3

Centre of gravity. Definition and general formulation. Centre of gravity of arc, plane area, area bounded by curve, solid of revolution, surface of revolution. Centre of gravity bounded area in polar coordinates. The theorem of Pappus, Friction, Statical, dynamical and limiting friction. Laws of friction. Limiting equilibrium. Coefficient of Friction. Angle of friction. Cone of friction. Equilibrium of a body on a rough inclined plane.

UNIT 4

Fundamental definitions and principles. Motion in a straight line. Simple harmonic motion. Motion under earth's attraction. Uniplanar motion where the accelerations parallel to fixed axes are given. Composition of simple harmonic motion. Tangential and normal accelerations. Constrained motion. Conservation of energy. The simple pendulum. Motion on a rough curve. Motion in a resisting medium. Motion where the mass moving varies.

Books Recommended

1. M.M. Rahman -- Statics, New Central Book Agency.
2. M.M. Rahman – Rigid Dynamics, New Central Book Agency.
3. I.H. Shames, G.K.M. Rao -- Engineering Mechanics: Statics and Dynamics, Pearson.
4. R.C. Hibbeler, A. Gupta -- Engineering Mechanics: Statics and Dynamics, Pearson.
5. P.N. Chatterji -- Dynamics, Educational Publishers.

MAT/H/C13: Metric Spaces and Complex Analysis

UNIT 1

Metric spaces: definition and examples. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set. Subspaces.

UNIT 2

Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Convergence in a metric space, dense sets. Limits, Limits involving the point at infinity, continuity.

UNIT 3

Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions.

UNIT 4

Definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem, Cauchy integral formula. Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series. Residue Theorem.

Books Recommended

1. S. Kumaresan -- Topology of Metric Spaces, Narosa.
2. G.F. Simmons -- Introduction to Topology and Modern Analysis, McGraw-Hill.
3. S. Ponnuswamy-- Foundations of Complex Analysis, Alpha Science International.
4. S. Ponnusawmy, H. Silvermann – Complex Variables with Applications, Birkhäuser.
5. R.V. Churchill & J.W. Brown -- Complex Variables and Applications, McGraw- Hill.

MAT/H/C14: Higher Trigonometry and Linear Algebra-II

UNIT 1

De Moivre's Theorem. Statement. Proof of De Moivre's theorem for integral indices. Alternative method. Proof for rational indices. All possible values of $(\cos x + i \sin x)^{p/q}$. Application of De Moivre's theorem for integral and fractional indices. Expansion of $\sin(nx)$, $\cos(nx)$ in series of $\sin x$, $\cos x$ and $\tan x$.

UNIT 2

Exponential, sine, cosine, and logarithms of a complex number. Definitions. Logarithmic, exponential and hyperbolic functions. Inverse functions - trigonometric and hyperbolic functions. Laws of logarithmic. Summation of series.

UNIT 3

Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators.

UNIT 4

Diagonalizability, invariant subspaces. Inner product spaces and norms, Gram - Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator, minimal solutions to systems of linear equations, Normal, unitary and self-adjoint operators.

Books Recommended

1. R.K. Ghosh, K.C. Maity --Higher Algebra, New Central Book Agency.
2. A.D. Gupta , S.B. Prasad -- Modern Approach to Intermediate Trigonometry, Bharati Bhawan Publishers.
3. A.D. Gupta, A.R. Mazumdar, S.B. Prasad -- Degree Level Trigonometry, Bharati Bhawan Publishers.
4. M. Artin -- Abstract Algebra, Pearson.
5. S. Kumaresan -- Linear Algebra: A Geometric Approach, Prentice Hall of India.
6. K. Hoffman, R. Kunze – Linear Algebra, Pearson.

MAT/H/GE1: Calculus

UNIT 1

Real variables. Continuous and discrete. Interval. Function. Domain of definition. Monotone functions. Inverse functions. Geometrical representations. Limit of a function on the real line. One-sided limits - right hand and left hand limits. Different types of limits. Theorems on limits.

UNIT 2

Continuous functions. Definitions. Discontinuity. Theorems and properties on continuity of functions. Uniform continuity.

UNIT 3

Derivatives. Definition. Theorems on derivatives. Continuity of a derivable function. Algebraic and transcendental functions. General rules of differentiation. Function of a function. Chain rule. Inverse function. Logarithmic differentiation. Implicit functions. Parametric equations.

UNIT 4

Derivative of a rate measure. Time rate of change. Rectilinear motion. Related rates. Geometric interpretation. Meaning of the sign of the derivative. Determination of multiple roots. Basic methods of integration. Integration by substitution. Integrations by parts. Integration of trigonometric and hyperbolic functions. Rational function of sine and cosine.

Books Recommended

1. H. Anton, I. Bivens, S. Davis – Calculus, Wiley.
2. J. Hass, C. Heil, M. Weir – Thomas' Calculus, Pearson.
3. T.M. Apostol – Calculus Volume I, Wiley.
4. T.M. Apostol – Calculus Volume II, Wiley.

MAT/H/GE2: Ordinary Differential Equations

UNIT 1

Differential equations. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form.

UNIT 2

Differential equations of the first order and first degree - Equation reducible to homogenous form. Bernoulli's equation. Exact differential equations. Differential equation of the first order but not of the first degree. Equations solvable for p , x , y . General and singular solutions. Clairaut's equation. Linear differential equations of higher order with constant coefficients. Complementary function and particular integrals.

UNIT 3

General solutions of homogenous equation of second order, principle of super position for homogenous equation, Wronskian: its properties and applications. Linear homogenous and non - homogenous equations of higher order with constant coefficients.

UNIT 4

Linear equation of second order. Standard form. Complete solution. Complementary function. Particular integral. Reduction to normal form. Transformation by changing the independent variable. Method of variation of parameters. Solution by operators. Simultaneous equations of the form $dx/P = dy/Q = dz/R$. Solution. Geometrical interpretation. Total differential equations. Solution by inspection.

Books Recommended

1. G.F. Simmons – Differential Equations with Applications and Historical Notes, CRC Press.
2. S.L. Ross -- Differential Equations, Wiley.
3. B. Barnes, G.R. Fulford -- Mathematical Modeling with Case studies: A Differential Equation Approach using Maple and Matlab, CRC Press/ Chapman and Hall.
4. C.H. Edwards, D.E. Penny, D. Calvis -- Differential Equations and Boundary Value Problems: Computing and Modeling, Pearson.

MAT/H/GE3: PDE and Systems of ODE

UNIT 1

Partial Differential Equations - Basic concepts and Definitions, Mathematical Problems. First - Order Equations: Classifications, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solutions of Quasi Linear Equations.

UNIT 2

Canonical Forms of First - order Linear Equations. Method of Separation of Variables for solving first order partial differential equations. Wave equation and Laplace equation. Classification of second order Linear Equations to canonical forms.

UNIT 3

The Cauchy Problem of an infinite string . Initial Boundary Value Problems, Semi - Infinite String with a fixed end, Semi - Infinite String with a Free end, Equations with non - homogenous boundary conditions.

UNIT 4

Non - Homogenous Wave Equation. Method of separation of variables. Solving the Vibrating String Problem. Solving the Heat Conduction problem. Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients. Basic Theory of linear systems in normal form, homogenous linear systems with constant coefficients: Two Equations in two unknown functions.

Books Recommended

1. T. Myint-U, L. Debnath -- Linear Partial Differential Equations for Scientists and Engineers, Birkhäuser.
2. S.L. Ross -- Differential Equations, Wiley.
3. M.L. Abell, J.P. Braselton -- Differential equations with MATHEMATICA, Elsevier Academic Press.

MAT/H/GE4: Numerical Methods

Use of Scientific Calculator is allowed.

UNIT 1

Finite differences. The operators Δ , ∇ and E . Properties. Central difference operators μ and δ . Gauss's central difference formula.

UNIT 2

Transcendental and Polynomial equations. Bisection method, Newton's method. Secant method. Rate of convergence of these methods.

UNIT 3

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

UNIT 4

Interpolation. Lagrange and Newton's methods. Error bounds. Gregory forward and backward difference interpolation. Numerical Integration: Trapezoidal rule, Simpson's 3/8th rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule.

Books Recommended

1. B. Bradie -- A Friendly Introduction to Numerical Analysis, Pearson.
2. M.K. Jain, S.R.K. Iyengar, R.K. Jain -- Numerical Methods for Scientific and Engineering Computation, New age International Publisher.
3. J.B. Scarborough – Numerical Mathematical Analysis, Oxford and IBH Publishers.
4. S.S. Sastry – Introductory Methods of Numerical Analysis, Prentice Hall India

MAT/H/DSE1A: Elementary Number Theory

UNIT 1

Divisibility. GCD & LCM. Euclidean Algorithm. Linear Diophantine equation. Primes. Co-primes. Prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues.

UNIT 2

Chinese Remainder theorem. Fermat's Little theorem. Wilson's theorem. Number theoretic functions, sum and number of divisors, totally multiplicative functions. Greatest integer function. De Polynac's Theorem

UNIT 3

Euler's phi-function. Euler's theorem, reduced set of residues, some properties of Euler's phi-function. . Definition and properties of the Dirichlet product. The Mobius Inversion formula.

UNIT 4

Order of an integer modulo n , primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties. Quadratic Residues. Quadratic reciprocity, quadratic congruences with composite moduli. The Jacobi symbol.

Books Recommended

1. D.M. Burton -- Elementary Number Theory, McGraw-Hill.
2. N. Robbins -- Beginning Number Theory, Jones & Bartlett Publishers.
3. I. Niven, H.S. Zuckerman, H.L. Montgomery – An Introduction to the Theory of Numbers, Wiley.

MAT/H/DSE1B: Analytic Geometry

UNIT 1

General equation of the 2nd degree. Chord of the contact. Pole and Polar. Conjugate points. Chord in terms of its middle point. Diameter. Conjugate diameter. Intersection of two conics. Conics through the points of intersection of two given conics.

UNIT 2

Pair of tangents. Director circle. Asymptotes. Polar equation of a conic. Derivatives of polar equation of a conic.

UNIT 3

Sphere. Equation. Section of a sphere by a plane. Equation of a circle in space. Intersection of two spheres. A sphere passing through a circle. Tangent and tangent plane to a sphere.

UNIT 4

Cone. Equation of a cone with its vertex at the origin. Right circular cone. Tangent plane to a cone. Reciprocal cone. Three mutually perpendicular generators. Equation of cylinder generated by lines parallel to a fixed line. Right circular cylinder.

Books Recommended

1. B. Das -- Analytic Geometry, Orient Book Company.
2. S.L. Loney -- The Elements of Coordinate Geometry, McMillan.
3. R.J.T. Bell -- Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan.

MAT/H/DSE2A: Boolean Algebra and Automata Theory

UNIT 1

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms.

UNIT 2

Definition, examples and properties of modular and distributive lattices. Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

UNIT 3

Introduction: Alphabets, strings, and languages. Finite Automata and Regular Languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.

UNIT 4

Context Free Grammars and Pushdown Automata: Context free grammars (CFG), Parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, Non-deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties. Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence. Undecidability: Recursively enumerable and recursive languages, undecidable properties about Turing machines: halting problem, Post Correspondence Problem, and undecidability problems about CFGs.

Books Recommended

1. B.A. Davey, H.A. Priestly -- Introduction to Lattices and Order, Cambridge University Press.
2. E.G. Goodaire, M.M. Parameter -- Discrete Mathematics with Graph Theory, Pearson.
3. R. Lidl, G. Pilz -- Applied Abstract Algebra, UTM, Springer.
4. J.E. Hopcroft, R. Motwani, J.D. Ullman -- Introduction to Automata Theory, Languages and Computation, Addison-Wesley.
5. H.R. Lewis, C.H. Papadimitriou -- Elements of the Theory of Computation, Prentice Hall.
6. J.A. Anderson -- Automata Theory with Modern Applications, Cambridge University Press.

MAT/H/DSE2B: Probability and Statistics-I

UNIT 1

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function.

UNIT 2

Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential. Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional functions.

UNIT 3

Expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution.

UNIT 4

Correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables. Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance.

Books Recommended

1. R.B. Hogg, J.W. McKean, A.T. Craig -- Introduction to Mathematical Statistics, Pearson.
2. I. Miller, M. Miller, J.E. Freund -- Mathematical Statistics with Applications, Pearson.
3. S. Ross -- Introduction to Probability Models, Academic Press.
4. A.M. Mood, F.A. Graybill, D.C. Boes -- Introduction to the Theory of Statistics, McGraw-Hill.

MAT/H/DSE3A: Theory of Equations

UNIT 1

General properties of polynomials. Graphical representation of a polynomial, maximum and minimum values of a polynomial. General properties of equations, positive and negative rule. Relation between the roots and coefficients of equations.

UNIT 2

Symmetric functions. Applications of symmetric function of the roots. Transformation of equations.

UNIT 3

Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Cardan's method of solution of cubic equations.

UNIT 4

Symmetric functions of the roots. Newton's theorem on the sums of powers of roots, homogenous products. Descartes' rule of signs. Separation of the roots of equations. Strum's theorem, Applications of Strum's theorem. Conditions for reality of the roots of an equation and biquadratic. Solutions of numerical equations.

Books Recommended

1. W.S. Burnside, A.W. Panton -- The Theory of Equations, Dublin University Press.
2. C.C. MacDuffee -- Theory of Equations, Wiley.
3. R.K. Ghosh, M.K. Maity -- Higher Algebra , New Central Book Agency.

MAT/H/DSE3B : Linear Programming

UNIT 1

Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format.

UNIT 2

Introduction to artificial variables, two - phase method, Big-M method and their comparison. Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

UNIT 3

Transportation problem and its mathematical formulation, northwest-corer method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem.

UNIT 4

Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem. Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

Books Recommended

1. M.S. Bazaraa, J.J. Jarvis, H.D. Sherali -- Linear Programming and Network Flows, Wiley.
2. F.S. Hillier, G.J. Lieberman -- Introduction to Operations Research, McGraw Hill.
3. H.A. Taha -- Operations Research: An Introduction, Pearson.
4. G. Hadley -- Linear Programming, Narosa.

MAT/H/DSE4A: Mechanics-II

UNIT 1

Moment and product of inertia. Momental ellipsoid. Principal axes, D'Alembert's principle. The general equations of motion. Independence of the motions of translation and rotation. Impulsive forces.

UNIT 2

Motion of a fixed axis. Moment of momentum. The compound pendulum. Reactions of the axis of rotation. Motion about a fixed axis (impulsive forces). Centre of percussion.

UNIT 3

Motion in two dimensions (Finite forces). Kinetic energy in two dimensions. Moment of momentum in two dimensions. Varying mass.

UNIT 4

Laws of Coulomb friction, application to simple and complex surface contact friction problems, transmission of power through belts, screw jack, wedge, first moment of an area and the centroid, other centres, Theorems of Pappus-Guldinus. Conservative force field, conservation for mechanical energy, work energy equation, kinetic energy and work, kinetic energy expression based on centre of mass, moment of momentum equation for a single particle and a system of particles.

Books Recommended

1. M. Ray, H.S. Sharma -- A Textbook of Hydrostatics, S. Chand.
2. M.M. Rahman - - Rigid Dynamics, New Central Book Agency.
3. I.H. Shames, G. K. M. Rao -- Engineering Mechanics: Statics and Dynamics, Pearson.
4. R.C. Hibbeler, A. Gupta -- Engineering Mechanics: Statics and Dynamics, Pearson.

MAT/H/DSE4B: Differential Geometry

UNIT 1

Space curve. Tangent. Arc length. Order of contact between curve and surface. Fundamental planes (osculating, normal and rectifying plane). Curvature. Torsion. Serret-Frenet formula. Direction cosines of the principal normal and binomial.

UNIT 2

Osculating circle. Osculating sphere. Involute. Evolute. Surface. Regular points and singularities on a surface. Curvilinear equation of the curve on the surface. Parametric curves. Tangent plane and normal and their Cartesian equation.

UNIT 3

Family of surface. Envelope. The edge of regression. Ruled surface. Developable surface. Necessary and sufficient condition that any surface represents a developable surface. Theorems related to developable surfaces. Developable associated with space curve. Theorems and questions on osculating developables. Polar developables. Rectifying developables.

UNIT 4

First fundamental form and its geometrical interpretation and properties. Second fundamental form and geometrical interpretation. Weingarten equations (derivative of N). Direction coefficients. Direction ratios. Differential equations of family of curves. Orthogonal trajectories. Condition for orthogonalities. Normal curvature (curvature of normal section). Menier's theorem. Principal direction. Principal curvature. First curvature. Mean curvature. Gaussian curvature. Minimal surface. Necessary and sufficient condition for a surface to be developable. Lines of curvature. Rodrique's formula. Lines of curvature as parametric curves. Euler's theorem.

Books Recommended

1. C.E. Weatherburn -- Differential Geometry of Three Dimensions, Volume I, Cambridge University Press.
2. C.E. Weatherburn -- Differential Geometry of Three Dimensions, Volume II, Cambridge University Press.
3. N. Prakash -- Differential Geometry: An Integrated Approach, McGraw Hill.

MAT/H/SEC1A: Logic and Sets

UNIT 1

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators.

UNIT 2

Propositional equivalence: Logical equivalences, Predicates and quantifiers: Introduction, Quantifiers, Binding Variables and Negations.

UNIT 3

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

UNIT 4

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations.

Books Recommended

1. R.P. Grimaldi, B.V. Ramana -- Discrete Mathematics and Combinatorial Mathematics: An Applied Introduction, Pearson Education.
2. P.R. Halmos -- Naive Set Theory, Springer.
3. E. Kamke -- Theory of Sets, Dover Publishers.

MAT/H/SEC1B: Computer Graphics

UNIT 1

Development of computer graphics: Raster Scan and Random Scan graphics storages, displays processors and character generators.

UNIT 2

Colour display techniques, interactive input/output devices. Points, lines and curves.

UNIT 3

Scan conversion, line-drawing algorithms, circle and ellipse generation, conic-section generation.

UNIT 4

Polygon filling anti aliasing. Two-dimensional viewing. Coordinate systems, linear transformations, line and polygon clipping algorithms.

Books Recommended

1. D. Hearn, M.P. Baker -- Computer Graphics, Prentice Hall.
2. J.D. Foley, A.V. Dam, S.K. Feiner, J.F. Hughes -- Computer Graphics: Principles and Practices, Pearson.
3. D.F. Rogers -- Procedural Elements for Computer Graphics, McGraw Hill.
4. D.F. Rogers, A.J. Adams -- Mathematical Elements for Computer Graphics, McGraw Hill.

MAT/H/SEC2A: Graph Theory

UNIT 1

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs.

UNIT 2

Sub graphs-matrices-connectedness, walks, trails and paths, connectedness and components.

UNIT 3

Isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph.

UNIT 4

Trees: characterization of trees, centre of trees. Travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended

1. S. Arumugam, S. Ramachandran -- Invitation to Graph Theory, Scitech Publications.
2. B.A. Davey, H.A. Priestly -- Introduction to Lattices and Order, Cambridge University Press.
3. E.G. Goodaire, M.M. Parameter -- Discrete Mathematics with Graph Theory, Pearson.
4. R. Lidl, G. Pilz -- Applied Abstract Algebra, UTM, Springer-Verlag.

MAT/H/SEC2B: Operating Systems: Linux

UNIT 1

Linux: The Operating System: Linux history, Linux features, Linux distributions, Linux's relationship to Unix, Overview to Linux Architecture.

UNIT 2

Installation, Start up scripts, system processes (an overview), Linux Security, The Ext2 and Ext3. File systems: General characteristics of The Ext3 File system, file permissions.

UNIT 3

User Management: Types of Users, the powers of Root, managing users (adding and deleting): using the command line and GUI tools.

UNIT 4

Resource Management in Linux: file and directory management, system calls for files. Process Management. Signals, IPC: Pipes, FIFOs, System V IPC, Message Queues, system calls for processes, Memory Management, library and system calls for memory.

Books Recommended

1. A. Robbins -- Linux Programming by Examples: The Fundamentals, Pearson.
2. K. Cox -- Red Hat Linux: Administrator's Guide, Prentice Hall.
3. W. R. Stevens -- UNIX Network Programming, Pearson.
4. S. Das -- UNIX: Concepts and Applications, McGraw Hill.
5. E. Siever, S. Figgins, R. Love, A. Robbins -- Linux in a Nutshell, O'Reilly Media.
6. N. Mathew, R. Stones, A. Cox -- Beginning Linux Programming, Wiley.

PASS COURSE SYLLABUS

MAT/P/DSC1A: Calculus

UNIT 1

Real variables. Continuous and discrete. Interval. Function. Domain of definition. Monotone functions. Inverse functions. Geometrical representations. Limit of a function on the real line. One-sided limits - right hand and left hand limits. Different types of limits. Theorems on limits.

UNIT 2

Continuous functions. Definitions. Discontinuity. Theorems and properties on continuity of functions. Uniform continuity.

UNIT 3

Derivatives. Definition. Theorems on derivatives. Continuity of a derivable function. Algebraic and transcendental functions. General rules of differentiation. Function of a function. Chain rule. Inverse function. Logarithmic differentiation. Implicit functions. Parametric equations.

UNIT 4

Derivative of a rate measure. Time rate of change. Rectilinear motion. Related rates. Geometric interpretation. Meaning of the sign of the derivative. Determination of multiple roots. Basic methods of integration. Integration by substitution. Integrations by parts. Integration of trigonometric and hyperbolic functions. Rational function of sine and cosine.

Books Recommended

1. H. Anton, I. Bivens, S. Davis – Calculus, Wiley.
2. J. Hass, C. Heil, M. Weir – Thomas' Calculus, Pearson.
3. T.M. Apostol – Calculus Volume I, Wiley.
4. T.M. Apostol – Calculus Volume II, Wiley.

MAT/P/DSC1B: Ordinary Differential Equations

UNIT 1

Differential equations. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form.

UNIT 2

Differential equations of the first order and first degree - Equation reducible to homogenous form. Bernonlli's equation. Exact differential equations. Differential equation of the first order but not of the first degree. Equations solvable for p , x , y . General and singular solutions. Clairaut's equation. Linear differential equations of higher order with constant coefficients. Complementary function and particular integrals.

UNIT 3

General solutions of homogenous equation of second order, principle of super position for homogenous equation, Wronskian: its properties and applications. Linear homogenous and non - homogenous equations of higher order with constant coefficients.

UNIT 4

Linear equation of second order. Standard form. Complete solution. Complementary function. Particular integral. Reduction to normal form. Transformation by changing the independent variable. Method of variation of parameters. Solution by operators. Simultaneous equations of the form $dx/P = dy/Q = dz/R$. Solution. Geometrical interpretation. Total differential equations. Solution by inspection.

Books Recommended

1. G.F. Simmons – Differential Equations with Applications and Historical Notes, CRC Press.
2. S.L. Ross -- Differential Equations, Wiley.
3. B. Barnes, G.R. Fulford -- Mathematical Modeling with Case studies: A Differential Equation Approach using Maple and Matlab, CRC Press/ Chapman and Hall.
4. C.H. Edwards, D.E. Penny, D. Calvis -- Differential Equations and Boundary Value Problems: Computing and Modeling, Pearson.

MAT/P/DSC1C: PDE and Systems of ODE

UNIT 1

Partial Differential Equations - Basic concepts and Definitions, Mathematical Problems. First - Order Equations: Classifications, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solutions of Quasi Linear Equations.

UNIT 2

Canonical Forms of First - order Linear Equations. Method of Separation of Variables for solving first order partial differential equations. Wave equation and Laplace equation. Classification of second order Linear Equations to canonical forms.

UNIT 3

The Cauchy Problem of an infinite string . Initial Boundary Value Problems, Semi - Infinite String with a fixed end, Semi - Infinite String with a Free end, Equations with non - homogenous boundary conditions.

UNIT 4

Non - Homogenous Wave Equation. Method of separation of variables. Solving the Vibrating String Problem. Solving the Heat Conduction problem. Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients. Basic Theory of linear systems in normal form, homogenous linear systems with constant coefficients: Two Equations in two unknown functions.

Books Recommended

1. T. Myint-U, L. Debnath -- Linear Partial Differential Equations for Scientists and Engineers, Birkhäuser.
2. S.L. Ross -- Differential Equations, Wiley.
3. M.L. Abell, J.P. Braselton -- Differential equations with MATHEMATICA, Elsevier Academic Press.

MAT/P/DSC1D: Numerical Methods

Use of Scientific Calculator is allowed.

UNIT 1

Finite differences. The operators Δ , ∇ and E . Properties. Central difference operators μ and δ . Gauss's central difference formula.

UNIT 2

Transcendental and Polynomial equations. Bisection method, Newton's method. Secant method. Rate of convergence of these methods.

UNIT 3

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

UNIT 4

Interpolation. Lagrange and Newton's methods. Error bounds. Gregory forward and backward difference interpolation. Numerical Integration: Trapezoidal rule, Simpson's 3/8th rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule.

Books Recommended

1. B. Bradie -- A Friendly Introduction to Numerical Analysis, Pearson.
2. M.K. Jain, S.R.K. Iyengar, R.K. Jain -- Numerical Methods for Scientific and Engineering Computation, New age International Publisher.
3. J.B. Scarborough – Numerical Mathematical Analysis, Oxford and IBH Publishers.
4. S.S. Sastry – Introductory Methods of Numerical Analysis, Prentice Hall India.

MAT/P/SEC1A: Logic and Sets

UNIT 1

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators.

UNIT 2

Propositional equivalence: Logical equivalences, Predicates and quantifiers: Introduction, Quantifiers, Binding Variables and Negations.

UNIT 3

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

UNIT 4

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations.

Books Recommended

1. R.P. Grimaldi, B.V. Ramana -- Discrete Mathematics and Combinatorial Mathematics: An Applied Introduction, Pearson Education.
2. P.R. Halmos -- Naive Set Theory, Springer.
3. E. Kamke -- Theory of Sets, Dover Publishers.

MAT/P/SEC1B: Computer Graphics

UNIT 1

Development of computer graphics: Raster Scan and Random Scan graphics storages, displays processors and character generators.

UNIT 2

Colour display techniques, interactive input/output devices. Points, lines and curves.

UNIT 3

Scan conversion, line-drawing algorithms, circle and ellipse generation, conic-section generation.

UNIT 4

Polygon filling anti aliasing. Two-dimensional viewing. Coordinate systems, linear transformations, line and polygon clipping algorithms.

Books Recommended

1. D. Hearn, M.P. Baker -- Computer Graphics, Prentice Hall.
2. J.D. Foley, A.V. Dam, S.K. Feiner, J.F. Hughes -- Computer Graphics: Principles and Practices, Pearson.
3. D.F. Rogers -- Procedural Elements for Computer Graphics, McGraw Hill.
4. D.F. Rogers, A.J. Adams -- Mathematical Elements for Computer Graphics, McGraw Hill.

MAT/P/SEC2A: Graph Theory

UNIT 1

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs.

UNIT 2

Sub graphs-matrices-connectedness, walks, trails and paths, connectedness and components.

UNIT 3

Isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph.

UNIT 4

Trees: characterization of trees, centre of trees. Travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended

1. S. Arumugam, S. Ramachandran -- Invitation to Graph Theory, Scitech Publications.
2. B.A. Davey, H.A. Priestly -- Introduction to Lattices and Order, Cambridge University Press.
3. E.G. Goodaire, M.M. Parameter -- Discrete Mathematics with Graph Theory, Pearson.
4. R. Lidl, G. Pilz -- Applied Abstract Algebra, UTM, Springer-Verlag.

MAT/P/SEC2B: Linear Algebra-III

UNIT 1

Rank. Row and Column rank. Linear equations. Solution of system of linear equations. Homogenous and non-homogenous. Coefficient matrix. Augmented matrix. Echelon form. Normal form.

UNIT 2

Vector spaces, subspaces, algebra of subspaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

UNIT 3

Linear transformations, null space, range, rank and nullity of a linear transformation, rank-nullity theorem, matrix representation of a linear transformation, algebra of linear transformations.

UNIT 4

Isomorphisms, Isomorphism theorems, invertibility and isomorphisms. Characteristic vector and root. Characteristic polynomial. Eigen space. Algebraic and geometric multiplicities. Minimal Polynomial. Cayley-Hamilton theorem.

Books Recommended

1. I.N. Herstein -- Topics in Algebra, Wiley.
2. J.A. Gallian -- Contemporary Abstract Algebra, Cengage Learning.
2. S. Kumaresan -- Linear Algebra: A Geometric Approach, Prentice Hall of India.
3. K. Hoffman, R. Kunze-- Linear Algebra, Pearson.

MAT/P/SEC3A: Probability and Statistics-II

UNIT 1

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions.

UNIT 2

Mathematical expectation, moments, moment generating function, characteristic function.

UNIT 3

Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

UNIT 4

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional functions.

Books Recommended

1. R.B. Hogg, J.W. McKean, A.T. Craig -- Introduction to Mathematical Statistics, Pearson.
2. I. Miller, M. Miller, J.E. Freund -- Mathematical Statistics with Applications, Pearson.
3. S. Ross -- Introduction to Probability Models, Academic Press.
4. A.M. Mood, F.A. Graybill, D.C. Boes -- Introduction to the Theory of Statistics, McGraw-Hill.

MAT/P/SEC3B: Basic Mechanics-I

UNIT 1

Coplanar forces. Moment of a system of coplanar forces. Equation of line of action of the resultant of a system of coplanar forces. Necessary and sufficient condition for the equilibrium of a system of coplanar forces acting on a rigid body.

UNIT 2

Astatic equilibrium. Equilibrium of a rigid body under three forces. (m,n) theorem.

UNIT 3

Work. Work done by a system of concurrent forces. Virtual work. Principle of virtual work for a system of coplanar forces acting on a particle. Omission of forces.

UNIT 4

Stability of equilibrium. Stable, unstable and neutral equilibrium. Work function test for the nature of stability of equilibrium. Energy test for equilibrium.

Books Recommended

1. M.M. Rahman -- Statics, New Central Book Agency.
2. M.M. Rahman – Rigid Dynamics, New Central Book Agency.
3. I.H. Shames, G.K.M. Rao -- Engineering Mechanics: Statics and Dynamics, Pearson.
4. R.C. Hibbeler, A. Gupta -- Engineering Mechanics: Statics and Dynamics, Pearson.
5. P.N. Chatterji -- Dynamics, Educational Publishers.

MAT/P/SEC4A: Basic Mechanics-II

UNIT 1

Moment and product of inertia. Momental ellipsoid. Principal axes, D'Alembert's principle. The general equations of motion. Independence of the motions of translation and rotation.

UNIT 2

Motion of a fixed axis. Moment of momentum. The compound pendulum. Reactions of the axis of rotation. Motion about a fixed axis (impulsive forces). Centre of percussion.

UNIT 3

Motion in two dimensions (Finite forces). Kinetic energy in two dimensions. Moment of momentum in two dimensions. Varying mass.

UNIT 4

Laws of Coulomb friction, application to simple and complex surface contact friction problems, transmission of power through belts, screw jack, wedge, first moment of an area and the centroid, other centres, Theorems of Pappus-Guldinus.

Books Recommended

1. M. Ray, H.S. Sharma -- A Textbook of Hydrostatics, S. Chand.
2. M.M. Rahman - - Rigid Dynamics, New Central Book Agency.
3. I.H. Shames, G. K. M. Rao -- Engineering Mechanics: Statics and Dynamics, Pearson.
4. R.C. Hibbeler, A. Gupta -- Engineering Mechanics: Statics and Dynamics, Pearson.

MAT/P/SEC4B: Complex Analysis

UNIT 1

Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

UNIT 2

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions.

UNIT 3

Definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem, Cauchy integral formula. Liouville's theorem and the fundamental theorem of algebra.

UNIT 4

Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series. Residue Theorem.

Books Recommended

1. S. Kumaresan -- Topology of Metric Spaces, Narosa.
2. G.F. Simmons -- Introduction to Topology and Modern Analysis, McGraw-Hill.
3. S. Ponnuswamy-- Foundations of Complex Analysis, Alpha Science International.
4. S. Ponnusawmy, H. Silvermann – Complex Variables with Applications, Birkhäuser.
5. R.V. Churchill & J.W. Brown -- Complex Variables and Applications, McGraw- Hill.

MAT/P/DSE1A: Elementary Number Theory

UNIT 1

Divisibility. GCD & LCM. Euclidean Algorithm. Linear Diophantine equation. Primes. Co-primes. Prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues.

UNIT 2

Chinese Remainder theorem. Fermat's Little theorem. Wilson's theorem. Number theoretic functions, sum and number of divisors, totally multiplicative functions. Greatest integer function. De Polynac's Theorem

UNIT 3

Euler's phi-function. Euler's theorem, reduced set of residues, some properties of Euler's phi-function. . Definition and properties of the Dirichlet product. The Mobius Inversion formula.

UNIT 4

Order of an integer modulo n , primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties. Quadratic Residues. Quadratic reciprocity, quadratic congruences with composite moduli. The Jacobi symbol.

Books Recommended

1. D.M. Burton -- Elementary Number Theory, McGraw-Hill.
2. N. Robbins -- Beginning Number Theory, Jones & Bartlett Publishers.
3. I. Niven, H.S. Zuckerman, H.L. Montgomery – An Introduction to the Theory of Numbers, Wiley.

MAT/P/DSE1B: Analytic Geometry

UNIT 1

General equation of the 2nd degree. Chord of the contact. Pole and Polar. Conjugate points. Chord in terms of its middle point. Diameter. Conjugate diameter. Intersection of two conics. Conics through the points of intersection of two given conics.

UNIT 2

Pair of tangents. Director circle. Asymptotes. Polar equation of a conic. Derivatives of polar equation of a conic.

UNIT 3

Sphere. Equation. Section of a sphere by a plane. Equation of a circle in space. Intersection of two spheres. A sphere passing through a circle. Tangent and tangent plane to a sphere.

UNIT 4

Cone. Equation of a cone with its vertex at the origin. Right circular cone. Tangent plane to a cone. Reciprocal cone. Three mutually perpendicular generators. Equation of cylinder generated by lines parallel to a fixed line. Right circular cylinder.

Books Recommended

1. B. Das -- Analytic Geometry, Orient Book Company.
2. S.L. Loney -- The Elements of Coordinate Geometry, McMillan.
3. R.J.T. Bell -- Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan.

MAT/P/DSE2A: Theory of Equations

UNIT 1

General properties of polynomials. Graphical representation of a polynomial, maximum and minimum values of a polynomial. General properties of equations, positive and negative rule. Relation between the roots and coefficients of equations.

UNIT 2

Symmetric functions. Applications of symmetric function of the roots. Transformation of equations.

UNIT 3

Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Cardan's method of solution of cubic equations.

UNIT 4

Symmetric functions of the roots. Newton's theorem on the sums of powers of roots, homogenous products. Descartes' rule of signs. Separation of the roots of equations. Strum's theorem, Applications of Strum's theorem. Conditions for reality of the roots of an equation and biquadratic. Solutions of numerical equations.

Books Recommended

1. W.S. Burnside, A.W. Panton -- The Theory of Equations, Dublin University Press.
2. C.C. MacDuffee -- Theory of Equations, Wiley.
3. R.K. Ghosh, M.K. Maity -- Higher Algebra , New Central Book Agency.

MAT/P/DSE2B : Linear Programming

UNIT 1

Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format.

UNIT 2

Introduction to artificial variables, two - phase method, Big-M method and their comparison. Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

UNIT 3

Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem.

UNIT 4

Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem. Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

Books Recommended

1. M.S. Bazaraa, J.J. Jarvis, H.D. Sherali -- Linear Programming and Network Flows, Wiley.
2. F.S. Hillier, G.J. Lieberman -- Introduction to Operations Research, McGraw Hill.
3. H.A. Taha -- Operations Research: An Introduction, Pearson.
4. G. Hadley -- Linear Programming, Narosa.