MATHEMATICS(HONOURS)

SEMESTER-I
C:1-CALCULUS-I

(Total Marks: 100)

Part-I(Marks: 70)
4 Lectures, 1 Tutorial (per week)

Unit-I

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of the type $e^{ax+b}\sin x$; $e^{ax+b}\cos x$; $(ax+b)^n\sin x$; $(ax+b)^n\cos x$; concavity and in ection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, LHospitals rule, applications in business, economics and life sciences.

Unit-II

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\,dx$; $\int \cos^n x\,dx$; $\int \tan^n x\,dx$; $\int \sec^n x\,dx$; $\int (\log x)^n\,dx$; $\int \sin^n x\cos^n x\,dx$; volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution.

Unit-III

Techniques of sketching conics, re ection properties of conics, rotation of axes and second degree equations, classi cation into conics using the discriminant, polar equations of conics. Sphere, Cone, Cylinder, Conicoids.

Unit-IV

Vector triple product, Introduction to vector functions, operations with vector-valued functions, lim-its and continuity of vector functions, di erentiation and integration of vector functions, tangent and normal components of acceleration.

C:2-ALGEBRA-I

Total Marks: 100-(Theory: 80 Marks+Mid-Sem: 20 Marks) 5
Lectures, 1 Tutorial (per week)

Unit-I

Polar representation of complex numbers, n-th roots of unity, De Moivres theorem for rational indices and its applications.

Unit-II

Equivalence relations, Basic Terminology, Functions, Inverse and composition of functions, One-to-One correspondence and cardinality of a set, Division algorithm, Divisibility and Euclidean algorithm, Prime numbers, Congruence relation between integers, Principles of Mathematical Induction, State-ment of Fundamental Theorem of Arithmetic.

Unit-III

Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax = b; solution sets of linear systems, applications of linear systems, linear independence.

Unit-IV

Introduction to linear transformations, Matrix of a linear transformation, Inverse of a matrix, Char-acterizations of invertible matrices. Subspaces of R^n, Dimension of subspaces of R^n and Rank of a matrix, Eigen values, Eigen Vectors and Characteristic equation of a matrix.

SEMESTER-II

C:3-REAL ANALYSIS (ANALYSIS-I)

Total Marks: 100-(Theory: 80 Marks+Mid-Sem: 20 Marks) 5 Lectures, 1 Tutorial (per week)

Unit-I

Review of Algebraic and Order Properties of R; Upper bound & Lower bound, Least upper bound (LUB), Greatest lower bound (GLB), LUB & GLB property of an ordered eld, Completeness of an ordered eld, Incompleteness of Q, Supremum and In mum, Roots, Archimedean property, Rational & Irrational density theorems, Decimal representations of real numbers.

Unit-II

Idea of countable, uncountable sets and theorems relating to these sets, Sequences, Convergence & divergence of sequences, Limit of a sequence & Limit Theorems, Monotonic sequences, Weierstrass completeness principle, Nested Intervals, Cantor's completeness principle, Idea about higher order cardinals (restricted).

Unit-III

Subsequences, Bolzano Weierstrass theorem for sequences, Cluster points, Cauchy(Fundamental) sequence, Cauchys Convergence Criterion, Limit superior and Limit inferior, Convergence and diver-gence of in nite series, Series of positive terms, Tests of convergence.

Unit-IV

Absolute convergence, Rearrangement of terms of a series, Conditional convergence of a series, Open sets, Closed sets, Limit points, Closure, Interior and Boundary of sets. Bolzano Weierstrass theorem for sets.

C-:4-DIFFERENTIAL EQUATIONS

(Total Marks:100)

Part-I(Marks: 70)

4 Lectures, 1 Tutorial (per week)

Unit-I

Basic concepts of Di erential equations and mathematical models. First order and rst degree Ordinary di erential equations(variables separable, homogeneous, exact, and linear). Applications of rst order di erential equations(Growth, Decay and Chemical Reactions, Heat ow, Oxygen debt, Economics). Equations of rst order but of higher degree.

Unit-II

Second order linear equations(both homogeneous and non-homogeneous) with constant coe cients, second order equations with variable coe cients, variation of parameters, method of undetermined coe cients, Euler's equation, Second order di erential equations with variable coe cients, Equations reducible to linear equations with constant coe cients.

Unit-III

Power series solutions of second order di erential equations.

Unit-IV

Laplace transforms and its applications to solutions of di erential equations.

SEMESTER-III

C-5: THEORY OF REAL FUNCTIONS (ANALYSIS-II)

Total Marks: 100-(Theory: 80 Marks+Mid-Sem: 20 Marks) 5 Lectures, 1 Tutorial (per week)

Unit-I

Limits of functions (approach), Sequential criterion for limits, Divergence criteria. Limit theo-rems, one-sided limits. In nite limits and limit at in nity. Continuous functions, Sequential criterion for continuity, Algebra of continuous functions and theorems related to continuity of functions.

Unit-II

Discontinuity and kinds of discontinuity, Further properties of continuity, Uniform continuity, Di er-entiable functions, Left hand & Right hand derivatives, Algebra of di erentiable functions, Caratheodory's theorem.

Unit-III

Mean value conditions, Global and local maximum & minimum, Rolle's theorem, Generalized mean value theorem, Cauchy mean value theorem, Lagrange's mean value theorem and their applica-tions, Darbouxs theorem, Indeterminant forms, Higher order derivatives(Leibnitz theorem), Taylor's theorem and its applications to approximating functions by means of polynomials.

Unit-IV

Maxima and Minima, Taylor's theorem with di erent forms of remainder, Maclaurin's theorem, Deduction of Taylor's theorem from mean value theorem, Taylor's and Maclaurin's in nite series, Taylors series and Maclaurins series expansions of exponential and trigonometric functions, $\ln(1 + x)$; $1=(ax + b)$ and $(1 + x)^n$:

C-6: GROUP THEORY (ALGEBRA-II)
Total Marks: 100-(Theory: 80 Marks+Mid-Sem: 20 Marks) 5 Lectures, 1 Tutorial (per week)

Unit-I

Symmetries of a square, Dihedral groups, De nition and examples of groups including permuta-tion groups and quaternion groups (illustration through matrices), Elementary properties of groups.

Subgroups and examples of subgroups, Centralizer, Normalizer, Center of a group, Product of two subgroups.

Unit-II

Properties of cyclic groups, Classi cation of subgroups of cyclic groups. Cycle notation for permu-tations, Properties of permutations, Even and Odd permutations, Alternating group, Properties of cosets, Lagranges theorem and consequences including Fermats Little theorem.

Unit-III

External direct product of a nite number of groups, Normal subgroups, Factor groups, Cauchys theorem for nite abelian groups.

Unit-IV

Group homomorphisms, properties of homomorphisms, Cayleys theorem, Properties of isomorphisms, First isomorphism theorem, Second and Third isomorphism theorems (Statements only).

C-7: PARTIAL DIFFERENTIAL EQUATIONS & SYSTEMS OF ORDINARY DIFFERENTIAL EQUATIONS

(Total Marks: 100)
Part-I(Marks: 70)
04 Lectures(per week)

Unit-I

Systems of Linear Di erential Equations: Basic theory of linear systems, Trial solution method for linear system with constant coe cients, Simultaneous linear rst order equations in three variables, Methods of solution, Pfa an di erential equations, methods of solutions of Pfa an di erential equations in three variables.

Unit-II

Formation of rst order partial di erential equations, Linear and non-linear partial di erential equa-tions of rst order, Special types of rst-order equations, Solutions of partial di erential equations of rst order satisfying given conditions.

Unit-III

Linear partial di erential equations with constant coe cients, Equations reducible to linear partial di erential equations with constant coe cients, Partial di erential equations with variable coe - cients, Some standard forms of variable coe cients.

Unit-IV

Laplace equation, Solution of Laplace equations by separation of variables, One-dimensional Wave equation, Solution of the Wave equation(method of separation of variables), Di usion equation, Solution of one-dimensional di usion equation, Method of separation of variables.

SEMESTER-IV

C-8: NUMERICAL METHODS

(Total Marks: 100)

Part-I(Marks: 70) 04
Lectures(per week)

Unit-I

Rate of convergence, Algorithms, Errors: Relative, Absolute, Round o , Truncation. Numeri-cal solution of non-linear equations : Bisection method, Regular-Falsi method, Secant method, Newton-Raphson method, Fixed-point Iteration method, Newton-Raphson method for multiple roots, Aitken's 4^2 process, Muller's method. Rate of convergence of these methods.

Unit-II

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

Unit-III

Polynomial interpolation: Existence uniqueness of interpolating polynomials, Lagrange and Newtons divided di erence interpolation, Error in interpolation, Central di erence & averaging operators, Gauss-forward and backward di erence interpolation, Simple numerical methods for derivatives, Interpolatory formulas.

Unit-IV

Numerical Integration: Some simple quadrature rules, Newton-Cotes rules, Trapezoidal rule, Simp-sons rule, Simpsons $\frac{3}{8}$-th rule, Compound quadrature rules, Compound mid-point rule, Compound Trapezoidal rule, Compound Simpsons rule, Gauss-Legendre 2-point & 3-point rules. Numerical solutions of Di erential Equations: Eulers method. Runge-Kutta methods of orders two, three and four.

C-9: RIEMANN INTEGRATION & SERIES OF FUNCTIONS (ANALYSIS-III)

Total Marks: 100-(Theory: 80 Marks+Mid-Sem: 20 Marks) 5
Lectures, 1 Tutorial (per week)

Unit-I

Riemann integration, Inequalities of upper and lower sums, Riemann conditions of integrability. Rie-mann sum and de nition of Riemann integral through Riemann sums, Equivalence of two de nitions, Riemann integrability of monotone and continuous functions, Properties of the Riemann integral, De nition and integrability of piecewise continuous and monotone functions, Fundamental theorems of Calculus.

Unit-II

Improper integrals; Series and Integrals, Absolute convergence of integrals, Convergence of Beta and Gamma functions.

Unit-III

Point-wise and Uniform convergence of sequence of functions, Cauchy's criterion & Weierstrass M-test for uniform convergence, Dedekind test, Uniform convergence and Continuity, Term by term integration of series, Term by term di erentiation of series.

Unit-IV

Power series (Cauchy Hadamard Theorem), Radius of convergence, Di erentiation and integration of power series, Abels Limit Theorem, Stirling's formula, More about Taylor's series, Weierstrass Approximation Theorem.

C-10: RING THEORY & LINEAR ALGEBRA (ALGEBRA-III)

Total Marks: 100-(Theory: 80 Marks+Mid-Sem: 20 Marks) 5 Lectures, 1 Tutorial (per week)

Unit-I

De nition and examples of rings, Properties of rings, Subrings, Integral domains and Fields, Char-acteristic of a ring, Ideal, Ideal generated by a subset of a ring, Factor rings, Operations on Ideals, Prime and Maximal ideals.

Unit-II

Ring homomorphisms, Properties of ring homomorphisms, Isomorphism Theorems I, II and III, Field of quotients.

Unit-III

Vector spaces, Subspaces, Algebra of subspaces, Quotient spaces, Linear combination of vectors, Linear span, Linear independence, Basis and Dimension, Dimension of subspaces.

Unit-IV

Linear transformations, Null space, Range, Rank and Nullity of a linear transformation, Matrix repre-sentation of a linear transformation, Algebra of linear transformations. Isomorphisms, Isomorphism theorems, Invertibility and Isomorphisms, Change of co-ordinate matrix.

SEMESTER-V
C-11: MULTIVARIATE CALCULUS (CALCULUS-II)

Total Marks: 100-(Theory:80 Marks+Mid-Sem: 20 Marks) 5 Lectures, 1 Tutorial (per week)

Unit-I

Functions of several variables, limit and continuity of functions of two variables, Partial di erentia-tion, Tangent planes, Approximation and Di erentiability, Chain rule for one and two independent parameters.

Unit-II

Directional derivatives and gradient, Maximal property of the gradient, Normal property of the gradient, Tangent planes and the normal lines, Extrema of functions of two variables, Method of Lagrange multipliers, Lagrange Multipliers, Constrained optimization problems, A geometrical interpretation.

Unit-III

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

Unit-IV

De nition of vector eld, Divergence and Curl, Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem and path independence for line integrals.

Unit-V

Green's theorem, Area as a line integral, Alternative forms of Green's theorem, Normal derivatives, Surface integrals, Integrals over parametrically de ned surfaces. Stokes theorem, The Divergence theorem.

C-12: PROBABILITY & STATISTICS

Total Marks:100-(Theory: 80 Marks+Mid-Sem: 20 Marks) 5 Lectures, 1 Tutorial (per week)

Unit-I

Sample space, Probability axioms, Independent events, Conditional probability & Bayes' theorem, Real random variables (discrete and continuous), Cumulative distribution function, Expectation of random variables, Some special expectations.

Unit-II

Multivariate distributions, Joint cumulative distribution functions, Joint probability distributions, Marginal & conditional distributions, Some probability distributions(Discrete case), Uniform distri-bution, Binomial distribution, Negative Binomial & Geometric distributions, Poisson distribution.

Unit-III

Some probability distributions(Continuous case), Uniform, Gamma, Exponential, Beta distributions, Normal distributions, Normal approximation to the Binomial distribution, Bivariate normal distribu-tion.

Unit-IV

Distribution of two random variables, Expectation of function of two random variables, Moment generating functions, Conditional distributions & expectations, Correlation coe cient, Co-variance, Independent random variables, Linear regression for two variables.

Unit-V

Limit theorems, Markov's inequality, Chebyshevs inequality, Statement and interpretation of Weak and Strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with nite variance, Markov Chains: Introduction, Chapman-Kolmogorov equa-tions.

SEMESTER-VI

C-13: METRIC SPACES & COMPLEX ANALYSIS (ANALYSIS-IV)

Total Marks: 100-(Theory: 80 Marks+Mid-Sem: 20 Marks) 5 Lectures, 1 Tutorial (per week)

Unit-I

Metric spaces: De nition and examples, Open & Closed spheres, Neighborhoods, Interior points, Open set, Closed set, Boundary points, Limit points & isolated points, Closure of a set, Dense sets, Separable metric spaces, Sequences in metric spaces, Convergent sequences, Cauchy sequences, Complete metric spaces, Distance between sets & diameter of a set, Subspaces, Cantor's theorem.

Unit-II

Continuous functions: De nition & characterizations, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Connectedness, Connected subsets of R;

Separated sets, Disconnected sets, Contraction mappings, Banach Fixed point theorem.

Unit-III

Properties of complex numbers, Regions in the complex plane, Functions of complex variable, Map-pings, Limits & Continuity of complex functions, Derivatives, Di erentiation formulas, Cauchy-Riemann equations, Su cient conditions for di erentiability, Polar Co-ordinates, Analytic functions, Examples of analytic functions.

Unit-IV

Exponential function, Logarithmic function, Trigonometric function, Derivatives of these functions, De nite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals, Theorems on antiderivatives, Cauchy-Goursat theorem (statement only), Cauchy integral formula, Its extension and consequences.

Unit-V

Liouvilles theorem and the Fundamental theorem of Algebra, Convergence of sequences and series, Taylor series with examples, Laurent series (without proof) with examples, Absolute and uniform convergence of power series.

C-14: LINEAR PROGRAMMING

Total Marks: 100-(Theory: 80 Marks+Mid-Sem: 20 Marks) 5 Lectures, 1 Tutorial (per week)

Unit-I

Introduction to linear programming problems(LPP), Mathematical formulation of the LPP with illustrations, Graphical method, General Linear programming problems, Canonical & standard form of LPP.

Unit-II

Theory of Simplex method, Optimality and unboundedness, the Simplex algorithm, Simplex method in tableau format, Introduction to arti cial variables, Two-phase method, Big-M method and their comparisons.

Unit-III

Duality in LPP: Introduction, General Primal-Dual pair, Formulation of the Dual problem, Primal-Dual relationships, Duality theorems, Complementary slackness theorem, Duality & Simplex method, Economic interpretation of the Duality.

Unit-IV

Transportation Problem(TP): LP formulation of TP, Existence of solution and Duality in TP, Solu-tion of Transportation problems, North-West corner method, Least-Cost method and Vogel approx-imation method for determination of starting basic solution, Algorithm for solving transportation problem, Assignment problem and its mathematical formulation, Solution methods of Assignment problem, Special cases in Assignment problems.

Unit-V

Games and Strategies: Introduction, Formulation of two person zero sum games, solving two per-son zero sum games, Maximin-Minimax principle, Games without saddle points, Games with mixed strategies, Graphical solution procedure to (2 n) and (m 2) games.