DEPARTMENT OF MATHEMATICS

CBCS Semester wise Course outcomes

Honours

Semester-I		
Sr. No.	**Name of the Course**	**Outcomes**
1	C1T:Calculus,Geometry &Differential Equation	➢ Learn and understand basic knowledge regarding limit, higher order derivatives, curve tracing, established some reduction formulae, Geometry in 2D and 3D and Construction of Differential equation and solve 1st order linear and non-linear differential equation.
2	C2T:Algebra	➢ Provides basic concept of various complex number, Theory of equation, inequality, set theory, relation, mapping. ➢ Adds some basic knowledge of Linear Algebra like rank of matrices, vector space, basis, and dimension.
3	GE-1:Calculus,Geometry &Differential Equation	➢ Learn and understand basic knowledge regarding limit, higher order derivatives, curve tracing, established some reduction formulae, Geometry in 2D and 3D and Construction of Differential equation and solve 1st order linear and non-linear differential equation.
Semester-II		
1	C3T:Real Analysis	➢ Provides basic concept of various Set theory, Real number system, point set topology, sequence and series.
2	C4T:Differential Equation &Vector Calculus	➢ Learn how to solve 2nd and higher order linear and non-linear differential equation, Lipschits condition, System of linear differential equations, power series solution and stability orbit. ➢ Learn and understand basic concept of vectors and their direction, magnitude. Various kind of vector multiplication, gradient, divergence, curl of a vector, various lines and path integration,conservative vector field.
3	GE-2:Algebra	➢ Provides basic concept of various complex number, Theory of equation, inequality, set theory, relation, mapping. ➢ Adds some basic concept of Linear Algebra like rank of matrices, vector space, basis, and dimension.

Semester-III		
1	C5T:Theory of Real Functions &Introduction to Metric Space	➢ Learn and understand basic knowledge regarding limit of functions, sequential criteria for limits, divergence, continuous function, uniform & non-uniform continuity, Rolle's theorem, Darboux's theorem, mean value theorem, Taylor's theorem with Lagrange's form, Cauchy mean value theorem, Taylor's & Maclaurin's series. ➢ Learn about open and closed balls, neighbourhood, open 7 closed set, diameter of a set, dense set, limit point of a set.
2	C6T:Group Theory 1	➢ Adds basic knowledge to tackle symmetries of a square, dihedral group, subgroups, centralizer, normalizer, centre of a group, product of two subgroups, cyclic groups, permutation, alternating groups, cosets, Lagrange's theorem, external direct product, normal subgroups,, Cauchy theorem for abelian group, homomorphism, Cayley's theorem, isomorphisms.
3	C7T:Numerical Methods CP7:Numerical Method Lab	➢ To develop knowledge in algorithms, convergence, Errors, relative, absolute, Round off, Truncation, Bisection method, Newton's method, secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods, Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis, Lagrange and Newton's methods. Error bounds. Finite difference operators, Gregory forward and backward difference interpolation, Methods based on interpolations, methods based on finite differences, Newton Cotes formula, Trapezoidal rule, Simpson's $1/3^{rd}$ rule, Simpsons $3/8^{th}$ rule, The algebraic eigen value problem: Power method, The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four etc. ➢ Aims to provide basic knowledge of programming language and computing various numerical method with the help of programming software.
4	GE-3: Differential Equation &Vector Calculus	➢ Learn how to solve 2^{nd} and higher order linear and non-linear differential equation, Lipschits condition, System of linear differential equations, power series solution and stability orbit. ➢ Learn and understand basic concept of vectors and their direction, magnitude. Various kind of vector multiplication, gradient, divergence, curl of a vector, various lines and path integration, conservative vector field.

	GE-3: Group Theory 1	➢ Adds basic knowledge to tackle symmetries of a square, dihedral group, subgroups, centralizer, normalizer, centre of a group, product of two subgroups, cyclic groups, permutation, alternating groups, cosets, Lagrange's theorem, external direct product, normal subgroups,, Cauchy theorem for abelian group, homomorphism, Cayley's theorem, isomorphisms.
	GE-3: Theory of Real Functions &Introduction to Metric Space	➢ Learn and understand basic knowledge regarding limit of functions, sequential criteria for limits, divergence, continuous function, uniform & non-uniform continuity, Rolle's theorem, Darboux's theorem, mean value theorem, Taylor's theorem with Lagrange's form, Cauchy mean value theorem, Taylor's &Maclaurin's series. ➢ Learn about open and closed balls, neighbourhood, open 7 closed set, diameter of a set, dense set, limit point of a set.
5	SEC-1:Object Oriented Programming in C++	➢ Learn programming paradigms, characteristics of object oriented programming languages, brief history of C++, structure of C++program, differences between C and C++, basic C++ operators, Comments, working with variables, enumeration, arrays and pointer, Objects, classes, constructor and destructors, friend function, overloading arithmetic operator and comparison operators, Template class in C++, copy constructor, subscript and function call operator. ➢ The ability to use C-Programming to determineroots of quadratic equation,addition,subtraction,multiplication of matrices
	SEC-1:Logic &Sets	➢ Learn and understand basic knowledge regarding proposition, truth table, negotiation, conjunction & disjunction, logical equivalences, logical operator, set, subset, set operator, Venn diagrams, finite & infinite set, classes of sets, power of a set, symmetric difference of two set, relations
		Semester-IV
1	C8T:Riemann Integration and Series of Functions	➢ Learn and solve inequalities of upper & lower sum, Darboux integration & theorem,, Riemann integral, Riemann integrability of monotone, continuous functions, improper integral, gamma & beta functions, pointwise& uniform convergence of sequence of a functions, theorem for continuity, derivability, intregrability of the limit functions of sequence of a functions, series of functions, Cauchy criteria for uniform convergence &weierstrass M-test, fourier series, dirichlet's condition, power series, radius of convergence, Cauchy hadamard theorem, Abel's

		theorem, Weierstrass approximation theorem.
2	C9T:Multivariate Calculus	➢ Adds basic knowledge to tackle functions of several variables, limit & continuity of functions of two or more variables, partial differentiation, total differentiability, chain rule, Lagrange multipliers, double integration over rectangular region, non-rectangular region, polar co-ordinates, triple integrals, change of variables in double & triple integral, vector field,, divergence & curl, line integrals, application of line theorem,, Green's theorem, surface integral, stoke's theorem, divergence theorem.
3	C10T:Ring Theory and Linear Algebra I	➢ Studying definitions & properties of rings, subrings, integral domains & fields, characteristic of a ring, ideal, ring homomorphism, isomorphism theorem I,II,III, field, vector spaces, subspaces, linear combination of vectors, linear spam, basis, dimension, linear transformation, null space, range, rank & nullity of linear transformation.
4	GE-4: Numerical Methods GE-4: Numerical Methods Lab	➢ To develop knowledge in algorithms, convergence, Errors, relative, absolute, Round off, Truncation, Bisection method, Newton's method, secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods, Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis, Lagrange and Newton's methods. Error bounds. Finite difference operators, Gregory forward and backward difference interpolation, Methods based on interpolations, methods based on finite differences, Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, The algebraic eigen value problem: Power method, The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four etc. ➢ Aims to provide basic knowledge of programming language and computing various numerical method with the help of programming software.
	GE-4:Partial Differential Equations &Applications	➢ Learn and understand basic knowledge regarding partial differential equations, method of characteristic for obtaining general solutions of quasi linear equation, canonical form of first order linear equations, method of separation of variables for solving first order partial differential equation, derivation of heat, wave & Laplace equation, reduction of second order linear equation of canonical form, string, solving heat & string problem, central force, constrained motion, varying mass.
	GE-4:Ring Theory and Linear Algebra I	➢ Studying definitions & properties of rings, subrings, integral domains & fields, characteristic of a ring, ideal, ring homomorphism, isomorphism theorem I,II,III, field,

		vector spaces, subspaces, linear combination of vectors, linear spam, basis, dimension, linear transformation, null space, range, rank & nullity of linear transformation.
	GE-4: Multivariate Calculus	➢ Adds basic knowledge to tackle functions of several variables, limit & continuity of functions of two or more variables, partial differentiation, total differentiability, chain rule, Lagrange multipliers, double integration over rectangular region, non-rectangular region, polar co-ordinates, triple integrals, change of variables in double & triple integral, vector field,, divergence & curl, line integrals, application of line theorem,, Green's theorem, surface integral, stoke's theorem, divergence theorem.
5	SEC-2:Graph Theory	➢ Studying definition, examples and basic properties of graphs, pseudo-graphs, complete graphs, Bipartite graphs isomorphism of graphs, Eulerian circuits, Eulerian graph, semi-Eulerian graph, theorems, Hamiltonian cycles, theorems Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm.
	SEC-2:Computer Graphics	➢ Study the nature of Development of computer Graphics: Raster Scan and Random Scan graphics storages, displays processors and character generators, colour display techniques, interactive input/output devices, Points, lines and curves: Scan conversion, line-drawing algorithms, circleand ellipse generation, conic-section generation, Two-dimensional viewing: Coordinate systems, linear transformations, line and polygon clipping algorithms.
	SEC-2:Operating System Linux	➢ The ability to use The operating system: Linux history, Linux features, Linux distributions, Linux's relationship to Unix,overviewofLinuxarchitecture,installation,startupscripts,system processes(an overview), Linux security, General characteristics of the Ext3file system, file permissions, types of users, the powers of root, managing users (adding and deleting): using the command line and GUI tools, ResourcemanagementinLinux:fileanddirectorymanagement,systemcallsforfilesprocessManagement,signals,IPC:Pipes,FIFOs,SystemVIPC,messagequeues,system calls for processes, memory management, library and system calls for memory.
Semester-V		
1	C11T: Partial Differential Equations &Applications	➢ Learn and understand basic knowledge regarding partial differential equations, method of characteristic for obtaining general solutions of quasi linear equation, canonical form of first order linear equations, method of separation of variables for solving first order partial

		differential equation, derivation of heat, wave & Laplace equation, reduction of second order linear equation of canonical form, string, solving heat & string problem, central force, constrained motion, varying mass.
2	C12T:Group Theory II	➢ Studying automorphism, inner automorphism, characteristic subgroup, external direct product, internal direct product, fundamental theorem for finite abelian groups, group actions, stabilizers &kernals, permutation, cayley's theorem, conjugation, class equation & consequences, conjugacy in S_n, p-groups, sylow's & Cauchy's theorem.
3	DSE-1:Linear Programming	➢ Aims to enlightenIntroduction tolinear programming problem. Theory of simplex method, graphical solution, convex sets, transportation problem & its mathematical formula, northwest-corner method, Gametheory:formulationoftwopersonzerosumgames,solvingtwopersonzerosum,games, games with mixed strategies, graphical solution procedure, linear programming solution of game.
	DSE-1:Point Set Topology	➢ Add concept of Countable andUncountable Sets, Schroeder-Bernstein Theorem, Cantor's Theorem. Cardinal numbers and cardinal arithmetic. Continuum Hypothesis, Zorns Lemma, Topological spaces, basis and Sub-basis for a topology, subspace topology, interior points, limit points, derived set, boundary of a set, closed sets, closure and interior of a set, Connected and path connected spaces, connected sets in R, components and path components, local connectedness. Compact spaces, compact sets in R. Compactness in metric spaces. Totally bounded spaces
	DSE-1: Theory of Equations	➢ Aims to enlighten students about General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, Relation between the roots and the coefficients of equations, Symmetric functions. Applications of symmetric function of the roots. Transformation of equations, Algebraic solutions of the cubic and bi-quadratic. Properties of the derived functions, Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations, separation of the roots of equations, Strums theorem. Applications of Strum's theorem, conditions for reality of the roots of an equation.
4	DSE-2: Probability & Statistics	➢ Adds basic knowledge to tackle Sample space, probability axioms, real random variables

		(discrete and continuous),cumulativedistributionfunction,probabilitymass/density functions, mathematical expectation, moments, moment generating function, characteristic function, 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 distributions, 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, Markovchains, Chapman-Kolmogorov equations, classification of states, Random Samples, Sampling Diatributions.
	DSE-2: Boolean Algebra and Automata Theory	➢ Learn and understand basic knowledge regarding 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, Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal and maximal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, Logic gates, switching circuits, Alphabets, strings, and languages. Finite automata and regular languages, Context free grammars and push down automata: Context free grammars (CFG), parse trees, ambiguitiesin grammars and languages, push down automaton (PDA) and the language accepted by PDA, deterministic PDA, Non-deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties, Turing Machines: Turing machine asamodel of computation, programming with a Turing machine, variants of Turing machine and their equivalence, Undecidbility: Recursivelye numerable and recursive languages, undecidable problems about Turing machines: halting problem.

	DSE-2: Portfolio Optimization	➢ Adds concept of Financial markets.Investment objectives. Measures ofreturnand risk. Types of risks. Risk free assets. Mutual funds. Portfolio ofassets. Expected risk and return of portfolio, Mean-variance portfolio optimization-the Markowitz model and the two-fund theorem, risk-free assets and one fund theorem, efficient frontier. Portfolios with short sales. Capital market theory, Capital assets pricing model-the capital market line, beta of an asset, beta of a portfolio, security market line, index tracking optimization models.
Semester –VI		
1	C13T:Metric Spaces and Complex Analysis	➢ Aims to enlighten students about sequence in metric spaces, cauchy sequences, cantor's theorem, complete metric spaces, sequential criterion & other characterizations of community, uniform continuity, connectedness, compactness, Heone-Borel property, constraction mappings, limit involving the point at infinity, continuity, region in complex plane, Cauchy-riemann equations, sufficient condition for differenciability, analytic functions, exponential, logarithm, trigonometry funtions, derivative of functions, upper bound of moduli of contour integrals, Cauchy-Goursat theorem, Cauchy integral formula, Liouville's theorem & fundamental theorem of algebra, convergence of sequence 7 series, Taylors series and its example, Laurent series, absolute & uniform convergence of power series.
2	C14T:Ring Theory and Linear Algebra II	➢ Adds concept of polynomial rings over commutative rings, division algorithm & consequences, principal ideal domains, factorization, reducibility test, Eisenstein criterion, Dualspaces, dualbasis, double dual, transpose of a linear transformation and its matrix in the dual basis, Eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, inner product spaces & norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, least approximation, normal & self-adjoint operators.
3	DSE-3: Mechanics	➢ Learn and understand basic knowledge regarding Co-planar forces. Astatic equilibrium. Friction. Equilibrium of a particle on a rough curve. Virtual work, Forces in three dimensions. General conditions of equilibrium. Centre of gravity for different bodies. Stable and unstable equilibrium, Equations of motion referred to a set of rotating axes. Motion of a projectile inaresisting medium. Stability of nearly circular orbits. Motion under the inverse square law.

		Slightly disturbed orbits. Motion of artificial satellites. Motion of a particle in three dimensions. Motion on a smooth sphere, cone, and on any surface of revolution. Degrees of freedom. Moments and products of inertia. Momental Ellipsoid. Principal axes. D'Alembert's Principle. Motion about a fixed axis. Compound pendulum. Motion of a rigid body in two dimensions under finite and impulsive forces. Conservation of momentum and energy.
	DSE-3: Number Theory	➢ Studying Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, Number theoretic functions, sum and numberof divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the Order of an integer modulon, primitive roots for primes, composite number shaving primitive roots, Euler's criterion, the Legendre symbol and its properties.
	DSE-3: Industrial Mathematics	➢ Learning about Medical Imaging and Inverse Problems. The content is based on Mathematics of X-ray and CT scan based on the knowledge of calculus, Illustration of Inverse problems through problems taught in Pre-Calculus, Calculus, Matrices and differential equations. Geological anomalies in Earth's interiorfrom measurements at its surface (Inverse problems for Natural disaster)and Tomography, X-ray: Introduction, X-ray behaviour and Beers Law, Radon Transform: Definition and Examples, Linearity, Phantom, Back Projection, CT Scan: Revision of properties of Fourier and inverse Fourier transforms and Applications of their properties in image reconstruction. Algorithms of CT scan machine. Algebraic reconstruction techniques abbreviated as ART with application to CT scan.
4	DSE-4: Mathematics Modeling	➢ Provides basic concept of Power series solution of Bessel's equation and Legendre's equation, Laplace transform and inverse transform, application to initial value problem up to second order, Monte-Carlo simulation modelling: simulating deterministic behaviour (area under a curve, volume under a surface), generating

		random numbers.
	DSE-4: Differential Geometry	➢ Learn and understand basic knowledge regarding Space curves. Planer curves, curvature, torsion and Serret-Frenet formula, osculating circles, Evolutesand involutes of curves, Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms. Principal and Gaussian curvatures. Lines of curvature, Euler's theorem, Rodrigue's formula, Developable associated with space curves and curves on surfaces, Minimal surface, Canonical geodesic equations. Nature of geodesics on a surface of revolution, Clairaut's theorem, Normal property of geodesics, Torsion of a geodesic, Geodesic curvature.
	DSE-4: Bio Mathematics	➢ Learn about mathematical biology, continuous model, logistic growth, gompretz growth, Malthus model, Holling type growth, population in competition, epidemic model, Activator-inhibit or system, insect out break model, multiple species communities and Routh-Hurwitz Criteria. Phase plane methodsandqualitative solutions, bifurcations and limit cycles with examples in the context of biological scenari, Spatial models, Overview of difference equations, steady state solution and linear stability analysis. Introduction to discrete models, linear models, growth models, decay models, drug delivery problem, discrete prey-predator models, density dependent growth models with harvesting, host-parasitoid systems (Nicholson-Bailey model), numerical solution of the models and its graphical representation. case studies. Optimal exploitation models, models in genetics, stage structure models, age structure models.

DEPARTMENT OF MATHEMATICS

CBCS Semester wise outcomes

General

Semester -I		
Sr.No.	**Name of the Course**	**Outcomes**
1.	DSC-1A:Dfferential Calculus	➢ To learn and understood basic knowledge regarding Limit and continuity, Successive differentiation, Leibnitz theorem, Tangent and normals, Rolls theorem, Lagrange theorem, Maxima and Minima.
Semester-II		
1.	DSC-1B:Differential Equation	➢ Learn the concept of exact different equation, integrating factors, basic theory of linear different equation, Wronskian and its properties, Cauchy Euler Equation, Charpits Methods.
Semester-III		
1	DSC-1C : Real Analysis	➢ Provides knowledge's and basic concept of Finite and infinite sum ,Bounded set, Archimedean property of R,Cauchy convergence criteria for sequence, Infinite series, Sequence and series of function,Pointwise and Uniform convergence, Power series and radius of convergence.
2	SEC-1:Logic and Sets	➢ Understanding the ideas of propositions, Truth table, Logical Equivalence, Quantifiers, Set, Subset, Power Set, Partion, Equivalence Relation, congruence modulo system.
Semester -IV		
1	DSC-1D:Algebra	➢ Learn the concept of definition of groups, Abelian groups, cyclic groups, various subgroups, cosets. Lagrange's theorem, normal groups, A brief discussion on ring, field, integral domain. Concept of characteristic of ring, field.

2	SEC-2:Graph Theory	➢ Learn and understand the basic properties of graph. Complete and bipartite graph, Eulerian graph, Hamiltonian circuit, Weighted graph, travelling salesman problem.
Semester-V		
1	DSE -1A:Linear Algebra	➢ A brief discussion on linear space including linear transformation. Linear span, linear dependence, independence, basis, dimension, rank nullity of a linear transformation, Isomorphism of spaces.
2	SEC-3:Number Theory	➢ A brief discussion on division algorithm, fundamental theorem of arithmetic, binary and decimal representation of integer.
Semester-VI		
1	DSE-1B:Linear Programming	➢ Concept of linear programming, convex set, theory of simplex method, two phase, duality, and game theory.
2	SEC-4:Probability and Statistics	➢ Basic idea of sampling space, probability distribution, density and mass function and expectation of probability