Name of the Programme: B.Sc. / B.A. MATHEMATICS (CBCS)

Programme Outcomes (PO)

After completing the Three Year Undergraduate Programme in Mathematics, Students are expected to achieve the following Programme Outcomes:

PO1: Foundation of Mathematical knowledge.

PO2: Problem Analysis

PO3: Mathematical Design and Development

PO4: Ability to investigate complex mathematical problems.

PO5: Use of modern tools in mathematics.

PO6: The Mathematics and Society

PO7: Environmental and Sustainability

PO8: Numerical and Logical Ability

PO9: Individual and Teamwork

PO10: Communication Skills

PO11: Career oriented knowledge in Mathematics.

PO12: Lifelong Learning

Programme Specific Outcomes (PSO)

The programme specific outcomes of the Undergraduate Programme in Mathematics are listed below. After completing the programme the students will be able to-

PSO1: Provide a strong foundation in Mathematics.

PSO2: Acquire the necessary skills and techniques for analyzing basic mathematical problems at the micro and macro levels that help them to pursue a successful career in Mathematics.

PSO3: Understand the essential mathematical tools/software to be applied in the analytical / computational aspects of Mathematics.

Course Outcomes (CO)

B.Sc. 1st Semester

Course Title: Calculus
Course Code: C1
Nature of Course: MAJOR
Total Credits: 06 (L=4, T=0, P=4)

On completion of this course, the students will be able to –

CO1: Understand different types of function such as Hyperbolic function, exponential function, sine function etc. concavity, convexity and optimum point of.
CO2: Understand the reduction formulae such as sinnxdx etc., finding volume by integration, by slicing, by cylindrical shells.
CO3: Learn how to parameterize a curve, introduction to conic and its related concepts.
CO4: Understand vector function and their properties such as limits, continuity, differentiation, integration etc. Finding tangent and normal component of acceleration using vector function.
CO5: Understand plotting of polynomials, transcendental function and parametric curve, using any software, basic matrix operation, Tracing of conics in Cartesian coordinates/ polar coordinates. Sketching conic sections.

Course Title: Algebra
Course Code: C1
Nature of Course: MAJOR
Total Credits: 04 (L=5, T=1, P=0)

At the end of this course, the student will be able to:

CO1: Learn to represent complex number in polar form and learn the De Moivre's theorem and its application.
CO2: Learn the types of function, introduction to divisibility property of number, equivalence relation and congruent, application of mathematical induction.

CO3: Learn the system of linear equation and method of finding solution of a system of linear equation.
CO4: Learn linear transformation and matrix representation of a linear transformation. Various properties of matrix, Eigen value, Eigen function and Characteristic equation of a matrix.

B.Sc. 2nd Semester

Course Title: Real Analysis
Course Code: C3
Nature of Course: MAJOR
Total Credits: 06 (L=5, T=1, P=0)

At the end of this course, the student will be able to:

CO1: Understand algebraic and order properties of R, topological properties of R. Archimedean property, concepts of limit points and illustration of Bolzano-Weirstrass theorem.
CO2: Understand sequences in details along with its properties. Basic theorems on convergency of a sequence, Bolzano Weierstrass Theorem for Sequences and Cauchy's Convergence Criterion.
CO3: Understand infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence, Alternating series, Absolute and Conditional convergence.

Course Title: Differential Equations
Course Code: C4
Nature of Course: MAJOR
Total Credits: 06 (L=4, T=0, P=4)

At the end of this course, the student will be able to:

CO1: Perform and understand DE and mathematical models. Technique and method to find complete solution of a DE. Exact differential equations and integrating factors, separable equations and equations reducible to separable form.

CO2: Understand compartmental model, exponential decay model, lake pollution model in details.

CO3: Understand equilibrium points, phase plane, analysis of predatory-prey model, epidemic model and battle model.

CO4: Plot solution of differential equation, testing convergency of a sequence using any online software, study various model in a software which are discussed in theory.

B.Sc. 3rd Semester

Course Title: Theory of Real functions
Course Code: C5
Nature of Course: MAJOR
Total Credits: 06 (L=5, T=1, P=0)

At the end of this course, the student will be able to:

CO1: Understand the idea of limits and continuity in details, Limits of functions, sequential criterion for limits. Infinite limits and limits at infinity. Continuous functions andit's properties, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity and it's criteria.
CO2: Understand differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Mean value theorem and all the theorem related to it.
CO3: Understand all forms of Mean value theorem. Taylor's theorem with Lagrange's and Cauchy's form of remainder. Application of Taylor's theorem to convex functions, relative extrema, series expansions of exponential and trigonometric functions, ln(1 + x), 1/ax+b and (1 +x) n .

Course Title: Group Theory I
Course Code: C6
Nature of Course: MAJOR
Total Credits: 06 (L=5, T=1, P=0)

At the end of this course, the student will be able to:
CO1: Understand symmetries of a square, definition and examples of Dihedral groups , permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.
CO2: Understand subgroups with example, centralizer, normalizer, center of a group, product of two subgroups.
CO3: Understand properties and classification of cyclic groups. Permutation in details, alternating group, properties of cosets, Lagrange's theorem and its' consequences.
CO4: Understand external direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.
CO5: Understand group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Course Title: PDE and System of ODE
Course Code: C7
Nature of Course: MAJOR
Total Credits: 06 (L=4, T=0, P=4)

At the end of this course, the student will be able to:

CO1: Understand the basic concepts and Definitions of PDE, First- Order Equations in details, Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Non-PDE, Charpit's method & Jacobi's method, Canonical Forms. Method of Separation of Variables.

CO2: Understand the classifications of second order linear equations as hyperbolic, parabolic or elliptic. Derivations of Heat equation, Wave equation and Laplace equation and their solutions. Reduction of second order Linear Equations to canonical forms.

CO3: Understand method of separation of variables, Solving the Vibrating String Problem, Solving the Heat Conduction problem.

CO4: Understand systems and types of linear DE . Differential operators, basic theory of linear systems in normal form, homogeneous linear systems with constant coefficients. The method of successive approximations, the Euler method, the modified Euler method, The Runge-Kutta method upto fourth order approximation.

CO5: Plot integral surface, solving differential equation with the method of characteristic and solving as well as plotting the solution of heat and wave equation using any programming software.

B.Sc. 4th Semester

Course Title: Numerical Methods
Course Code: C8
Nature of Course: MAJOR
Total Credits: 06 (L=4, T=0, P=4)

At the end of this course, the student will be able to:

CO1: Understand algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation.

CO2: Understand transcendental and Polynomial equations: Bisection method, Newton's method, Secant method. Rate of convergence of these methods.

CO3: Understand system of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

CO4: Understand interpolation BY Lagrange and Newton's methods. Finite difference operators. Gregory forward and backward difference interpolation.

CO5: Understand trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule.

CO6: Understand Euler's method. Runge-Kutta methods of orders two and four.

CO7: Perform for any CAS (Computer-aided software). Use of array and loop and different functions, implementing various numerical methods Method.

Course Title: Riemann Integration and Series of Functions

Course Code: C9

Nature of Course: MAJOR

Total Credits: 06 (L=5, T=1, P=0)

At the end of this course, the student will be able to:

CO1: Understand Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability.

CO2: Understand Riemann sum and definition of Riemann integral through Riemann sums. Riemann integrability of monotone and continuous functions and piecewise continuous function. Properties of the Riemann integral. Intermediate Value theorem for Integrals and Fundamental theorems of Calculus.

CO3: Understand improper integrals; Convergence of Beta and Gamma functions.

CO4: Understand pointwise and uniform convergence, Theorems on limit, continuity, derivability and integrability of a sequence of functions. Theorems on the continuity and derivability of the sum function of a series of functions. Cauchy criterion for uniform convergence and Weierstrass M-Test.

CO5: understand limit superior and inferior. Differentiation and integration of power series, radius of convergence, Cauchy Hadamard Theorem, , Abel's Theorem, Weierstrass Approximation Theorem.

Course Title: Rings Theory and Linear Algebra I
Course Code: C10
Nature of Course: MAJOR
Total Credits: 06 (L=5, T=1, P=0)

At the end of this course, the student will be able to:
CO1: Understand the definition and examples of rings, properties of rings, integral domains and fields, characteristic of a ring. Ideal generated by a subset of a ring, factor rings, operations on prime and maximal ideals.
CO2: Understand Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients.
CO3: Understand Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.
CO4: Understand Linear transformations, null space, range, rank and nullity, matrix representation and algebra of linear transformations. Invertibility and isomorphisms, change of coordinate matrix.

B.Sc. 5th Semester

Course Title: Multivariate Calculus
Course Code: C11
Nature of Course: MAJOR
Total Credits: 06 (L=5, T=1, P=0)

At the end of this course, the student will be able to:
CO1: Understand limit and continuity and extrema of functions of two variables, PDE , total differentiability and sufficient condition for differentiability. Chain rule, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, method of Lagrange multipliers, constrained optimization problems, definition of vector field, divergence and curl.
CO2: Understand double integration, double integration, Double integrals in polar co-ordinates, Triple integrals, Triple integral. Volume by triple integrals, cylindrical and spherical co-ordinates.
CO3: Understand change of variables in double integrals and triple integrals. Line integrals and it's applications in mass and work. Fundamental theorem for line integrals, conservative vector fields.
CO4: Understand Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem.

Course Title: Rings Theory II
Course Code: C12
Nature of Course: MAJOR
Total Credits: 06 (L=5, T=1, P=0)

At the end of this course, the student will be able to:
CO1: Understand Inner automorphism, automorphism groups, automorphism groups, applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties.
CO2: Learn the properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups.
CO3: Understand Groups action, class equation and consequences, conjugacy in Sn, p-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of An for $n \geq 5$, non-simplicity tests.

Course Title: Analytical Geometry
Course Code: DSE 1
Nature of Course: Discipline Specific Elective
Total Credits: 06 (L=5, T=1, P=0)

At the end of this course, the student will be able to:
CO1: Understand techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola. Classification of quadratic equations representing lines, parabola, ellipse and hyperbola.

CO2: Understand Spheres, Cylindrical surfaces. Illustrations of graphing standard quadric surfaces like cone, ellipsoid.

Course Title: Mathematical Modelling
Course Code: DSE 2
Nature of Course: Discipline Specific Elective
Total Credits: 06 (L=4, T=0, P=4)

At the end of this course, the student will be able to:
CO1: Understand Power series solution of a DE about an ordinary point, solution about a regular singular point, Bessel's and Legendre's equation, Laplace transform and inverse transform, application to initial value problem up to second order.
CO2: Understand Monte Carlo Simulation Modeling, Generating Random Numbers, Queuing Models, Overview of optimization modeling, Linear Programming Model: geometric solution algebraic solution, simplex method, sensitivity analysis.

CO3: Plot Legendre Polynomial, Bessel function, generating random number, automatic computation of coefficients in the series solution near ordinary points, and the Frobenius Series Method. Simulate area under a curve, simulate volume under a surface. Programming of either one of the queuing model Single server queue and Simplex method for 2/3variables using any programming software.

B.Sc. 6th Semester

Course Title: Metric Spaces and Complex Analysis
Course Code: C13
Nature of Course: MAJOR
Total Credits: 06 (L=5, T=1, P=0)

At the end of this course, the student will be able to:
CO1: Understand the Introduction to Metric spaces. Sequences in metric spaces. Complete Metric Spaces. Concept of set neighborhood and limit point, Cantor's theorem. Subspaces, dense sets, separable spaces.
CO2: Understand the Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, compactness, Banach Fixed point Theorem. Connectedness in R.
CO3: Understand the Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variables, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations and its application.
CO4: Understand the Analytic functions with example, exponential, logarithmic, trigonometric function. Derivatives and definite integrals of functions. Contour integrals and its examples. Cauchy integral formula.
CO5: Understand the Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples.
CO6: Understand the Laurent series and its examples, absolute and uniform convergence of power series.

Course Title: Ring Theory and Linear Algebra II
Course Code: C14
Nature of Course: MAJOR
Total Credits: 06 (L=5, T=1, P=0)

At the end of this course, the student will be able to:
CO1: Understand the polynomial rings over commutative rings, division algorithm and consequences, PID , factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in Z[x]. Divisibility in ID, irreducibles, primes, UFD, ED.

CO2: Understand the dual spaces, transpose of a linear transformation and its matrix in the dual basis, annihilators, Eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator.
CO3: Understand the inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint and minimal solutions to systems of a linear operator, Least Squares Approximation, linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.

Course Title: Discrete Mathematics
Course Code: DSE 3
Nature of Course: Discipline Specific Elective
Total Credits: 06 (L=5, T=1, P=0)
At the end of this course, the student will be able to:
CO1: Understand the definition, examples and basic properties of ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms.
CO2: Understand the definition, examples and properties of modular and distributive lattices, Boolean algebras, minimal forms of Boolean polynomials, Quinn- McCluskey method, Karnaugh diagrams, switching circuits and applications.
CO3: Understand the definitions, examples and basic properties of different types of graph, isomorphism of graphs, paths and Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, traveling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Course Title: Mathematical Methods
Course Code: DSE 4
Nature of Course: Discipline Specific Elective
Total Credits: 06 (L=4, T=0, P=4)

At the end of this course, the student will be able to:
CO1: Understand Fourier Series for even and odd functions, Dirichlet conditions, Half range Fourier series.

CO2: Understand definition existence, properties and preliminary results on Laplace transform. Laplace transform of some elementary functions, derivatives and Integrals. Shifting theorem, Change of scale property.

CO3: Understand Inverse Laplace Transform and it's property, related theorems. Convolution theorem.

CO4: Understand definition of Fourier Transform and it's Inverse , Inverse theorem for Fourier transform, Fourier Sine and Fourier cosine transforms and their inversion formula, Linearity property, change of scale property , shifting property, modulation theorem, convolution theorem.

CO5: Understand applications of Fourier and Laplace transform: Solution of Boundary value problems and initial value problems in 1-D and 2-D cases. Solution of Laplace and Poisson equations in 2-D cases.

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