GOVERNMENT OF WEST BENGAL
Office of the Principal
GOVERNMENT GENERAL DEGREE COLLEGE AT PEDONG
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सत्यमेव जयते
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DEPARTMENT OF MATHEMATICS

PROGRAMME OUTCOMES:

1. Application of fundamental mathematics
2. Skills in Programming languages
3. Development of critical thinking
4. Ability to use in Mathematical real life problems
5. Skills in performing analysis and interpretation of data
6. Interdisciplinary approach
7. To inculcate awareness on environment and inclusive growth
8. Motivate towards higher studies and self reliance
9. Development of ICT skills

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COURSE OUTCOMES:

SEMESTER- I

❖ **Unit-1, 2, 3, 4 of Core Course 1 (Calculus, Geometry, and Differential Equation)**

Units 1 and 2:

Learning Calculus Results : After finishing this section of the course, the learner will be able to

● Recognize the characteristics of hyperbolic functions.

● Locate higher-order derivatives and use the Leibnitz rule to address issues pertaining to them. Plot the polynomial graphs of degrees four and five, as well as their derivative and second derivative graphs, and compare them.

● Use the idea and tenets of differential calculus to determine the curve's curvature, concavity, points of inflection, envelopes, and rectilinear asymptotes (only in Cartesian and parametric form).

● Trace standard curves in polar and Cartesian coordinates. Draw parametric curves, such as trochoid, cycloid, epicycloid, and hypocycloid.

● Utilize the notion and tenets of differential calculus to address various geometric and physical issues that may emerge in the fields of business, economics, and biological sciences.

● Derive reduction formulae for some complex integrations and so integrate functions of a higher degree that are appropriate in real-life situations.

● Solve a variety of limit issues using L'Hospital's rule.

● Use the integral calculator to find the area under a curve, the surface area, the volume of the surface of revolution, and the arc length of a curve and parametric curves.

● Visually obtain the curves' revolution surface.

Unit 3:

Studying Geometry Results: After finishing this section of the course, the student will be able to

● Rotate the axes to transform the coordinate system, lowering various second-degree equations to their corresponding simpler versions. This will also help you classify the constants using the discriminant.

● Learn about the polar equations of constants and their tangents and normals.

● Recognize the vocabulary used in geometry and possess a thorough understanding of the following: planes, straight lines in three dimensions, spheres, cylindrical surfaces, central conicoids, paraboloids, plane sections of conicoids, and the tangent and normals of the conicoids.

● Possess a classification scheme for quadrics.

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Create a concept for the generating lines.
● Recognize how to graph common quadric surfaces such as cones, paraboloids, hyperboloids, and ellipsoids.
● Classify distinct geometric solids and visually demonstrate geometric forms using instructional aids, ideally free software. ✏Conics are tracked in polar and cartesian coordinates. ✏ Using cartesian coordinates, sketch the ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic paraboloid, and hyperbolic paraboloid

Unit 4(ODE):

Learning Outcomes: After completing this course, the student will be able to recognize the kind of provided differential equation and choose and use the proper analytical method to solve it. Students will be proficient in the following categories of differential equations:
● First-order differential equations: exact differential equations and integrating factors, uniqueness and existence theorem of Picard, special integrating factors and transformations, linear equations and Bernoulli equations (Statement only).
● Equations that are reducible to linear form and linear equations. First order higher degree equations solvable for x, y and p. Clairaut's equations and singular solution.
● Fundamentals of linear systems in normal form, homogeneous linear systems with constant coefficients, two equations in two unknown functions.
● Second-order linear differential equations; Wronskian and its properties and applications; the Euler equation; the method of unknown coefficients of efficiency; the method of parameter change.

Course: Algebra 1, Units 1, 2, 3, 4, and 5:

Learning Objectives: After completing this course, the student will have a firm grasp of the following key ideas in linear algebra, abstract algebra, and classical algebra:

Unit 1:

● De Moivre's theorem for rational indices and its applications; polar representation of complex numbers; nth roots of unity, the complex variable's exponential, logarithmic, trigonometric, and hyperbolic functions.
● Equation theory: Root-coefficient relationship, equation transformation, Descartes' rule of signs, Sturm's theorem, cubic equation (solution via Cardan's approach) and quadratic equation (solution via Ferrari's method).
● Inequality: The Cauchy-Schwartz inequality involving AM ≥ GM ≥ HM.
● Linear difference equations up to second order with constant coefficients.

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Unit 2 :

- Relation : Equivalence Relation, Equivalence Classes & Partition, Partial Order Relation, Poset, Linear Order Relation.
- Mapping : Injective, Surjective, Invertiable mapping, Composition of mappings,relation between the composition of mappings and various set theoretic operations.
  Meaning and properties of $f^{-1}(B)$, for any mapping $f:X\to Y$ and $B\subseteq Y$.
- Well-ordering property of positive integers, Principles of Mathematical induction,division algorithm, di-visibility and Euclidean algorithm. Prime numbers and their properties, Euclid's theorem. Congruence relation between integers. FundamentalTheorem of Arithmetic. Chinese remainder theorem. Arithmetic functions, some arithmetic functions such as ϕ, τ, σ and their properties.

Unit-3, 4 & 5:

- Rank of a matrix, inverse of a matrix, characterizations of invertible matrices.
- 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.

SEMESTER - II

CoreCourse-3(RealAnalysis:Unit-1,2,3)

Learning Outcomes:

After completion of this course, the students will be able to think about the basic proof techniques and fundamental definitions related to the real number system. They can demonstrate some of the fundamental theorems of analysis. The students will gradually develop Analysis skills in sets, sequences and infinite series of Real Numbers covered by the three respective units as follows:

Unit-1:

- Intuitive idea of real numbers. Mathematical operations and usual order of Real numbers revisited with their properties (closure,commutative,associative,identity, inverse, distributive). Idea of countable sets, un-countable sets and uncountability of R. Concept of bounded and unbounded sets in R.L.U.B. (supremum), G.L.B. (infimum)

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of a set and their properties .L.U.B. axiom or order completeness axiom. Archimedean property of R. Density of rational and Irrational numbers in R.

- Intervals. Neighbourhood of a point. Interiorpoint. Open set. Union, intersection of open sets. Limit point and isolated point of a set. Bolzano-Weirstrass theorem for sets. Existence of limit Point of every uncountable set as a consequence of Bolzano-Weirstrass theorem. Derived set. Closed set. Complement of open set and closed set.Union and intersection of closed sets as a consequence. No nonempty proper subset of R is both open and closed. Dense set in R as a set having non-empty intersection with every open interval.

Unit 2 :

- Real sequence. Bounded sequence. Convergence and non-convergence. Examples. Boundedness of convergent sequence. Uniqueness of limit. Algebra of limits.
- Relation between the limit point of a set and the limit of a convergent sequence of distinct elements. Monotone sequences and their convergence.

Sandwich rule.Nested interval theorem. Limit of some important sequences.Cauchy's first and second limit theorems.

- Subsequence, Subsequential limits. A bounded sequence $\{x_n\}$ is convergent if

And only if limsupx_n = liminfx_n. Every sequence has a monotone subsequence. Bolzano-Weirstrass theorem for sequence. Cauchy's convergence criterion. Cauchysequence.

Unit-3

- Infinite series, convergence and non-convergence of infinite series.
- Cauchy criterion, tests for convergence: comparison test, limit comparison test, ratio test.
- Cauchy's n-th root test, Kummer's test and Gauss test (statements only). Alternating series.
- Leibniz test. Absolute and conditional convergence.

Core Course-4(Differential Equations: Unit-1, 2, 3 & 4)

Learning Outcomes:

Unit-1

- Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.
- Linear differential equations of second order, Wronskian its properties and applications, Euler equation, method of undetermined coefficients, method of variation of parameters.

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Unit-2 & 3

- System of linear differential equations, types of linear systems, Differential operators, an operator method for linear systems with constant coefficients.
- Planar linear autonomous systems : Equilibrium (critical) points, Interpretation of the phase plane and phase portraits.
- Power series solution of a differential equation about an ordinary point, solution about a regular singular point(upto second order).

Unit-4

Graphical Demonstration (Teaching Aid-Preferably by computer software)

The students will gain hands on expertise in graphical demonstration of the following, Using computer software or otherwise:

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).
8. Predator-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).
9. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).
10. Battle model (basic battle model, jungle warfare, long range weapons).
11. Plotting of recursive sequences.
12. Study the convergence of sequences through plotting.
13. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent sub-sequences from the plot.
14. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.
15. Cauchy's root test by plotting nth roots.

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Semester III:

Core Course-5 (Theory of Real Functions: Unit-1, 2 & 3)
Learning Outcomes: After completion of this course, the students will be able to understand the concept of real-valued functions, limit, continuity and differentiability in detail.
They can find expansions of real functions in series forms. The students will become conversant with many of the important theorems of Differential Calculus after the completion of this Core Course which has been covered in the following two units:

Unit-1:

- Limits of functions, sequential criterion for limits. Algebra of limits for functions , effect of limit on inequality involving functions, one sided limit. Infinite limits and limits at infinity. Some Important examples of limits.
- Continuity of a function on an interval and at an isolated point. Sequential criteria for continuity. Concept of oscillation of a function at a point. A function is continuous at x if and only if its oscillation at x is zero. Familiarity with the figures of some well-known functions :$y = x^a (a = 2, 3, -1, -2), |x|, sinx, cosx, tanx, logx, e^x$. Algebra of continuous functions as a consequence of algebra of limits. Continuity of composite functions. Examples of continuous functions. Continuity of a function at a point does not necessarily imply the continuity in some neighbourhood of that point.
- Bounded functions. Neighbourhood properties of continuous functions regarding boundedness and maintenance of the same sign. Continuous function on $[a,b]$ is bounded and attains its bounds. Intermediate value theorem.
- Discontinuity of functions, type of discontinuity. Step functions. Piecewise continuity. Monotone functions. Monotone functions can have only jump discontinuity. Monotone functions can have at most countably many points of discontinuity. Monotone bijective function from an interval to an interval is continuous and its inverse is also continuous.
- Uniform continuity. Functions continuous on a closed and bounded interval is uniformly continuous. A necessary and sufficient condition under which a continuous function on a bounded open interval will be uniformly continuous.

A sufficient condition under which a continuous function on an unbounded open interval will be uniformly continuous (statementonly). Lipschitz condition and uniform continuity.

Unit-2:

- Differentiability of a function at a point and in an interval, algebra of differentiable functions.Meaning of sign of derivative. Chain rule.

- Darboux theorem, Rolle's theorem, Mean value theorems of Lagrange and Cauchy— as an application of Rolle'stheorem.

Unit-3:

- Taylor's theorem on closed and bounded interval with Lagrange's and Cauchy's form of remainder deduced from Lagrange's and Cauchy's Mean value theorem respectively. Expansion of $e^x, \log(1+x), (1+x)^m, sinx, cosx$ with their range of validity (assuming relevant theorems). Application of Taylor's theorem to inequalities.
- Statement of L' Hospital's rule and its consequences. Point of local extremum (maximum, minimum) of a function in an interval. Sufficient condition for the existence of a local maximum/minimum of a function at a point (statemen tonly). Determination of local extremum using first order derivative. Application of the principle of maximum/minimum in geometrical problems.

Core Course-6: (Group Theory: Unit-1,2,3 & 4)

Learning Outcomes: On the completion of this course, the students will understand the basic concepts of Group Theory in Abstract/Modern Algebra covered by the following three units:

Unit-1:

Symmetries of a square, definition of group, examples of groups including permutation groups, dihedral groups and quaternion groups (through matrices), elementary properties of groups, examples of commutative and non-commutative groups.

Subgroups and examples of subgroups, necessary and sufficient condition for an on empty subset of a group to be a subgroup. Normalizer, centralizer, center of a group, product of two subgroups.

Unit-2:

Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, order of an element, order of a group. Lagrange's theorem and consequences including Fermat's Little theorem.

Unit-3 & 4:

Normal subgroup and its properties. Quotient group. Group homomorphism, properties of homomorphism, correspondence theorem and one-one correspondence between the set of all normal subgroups of a group and the set of all congruences on that group, Cayley's theorem, properties of isomorphisms. First, Second and Third isomorphism theorems.

Core Course-7: (Partial Differential Equation: Unit-1,2,3 & 4)

Learning Outcomes:

On completion of this unit of the course, the student will be able to understand, derive and solve different types of partial differential equations which may arise in real life problems:

Unit-1 & 2:

• Partial differential equations of the first order, Lagrange's solution, non- linear first order partial differential equations, Charpit's general method of solution, some special types of equations which can be solved easily by methods other than the general method.

• Derivation of heat equation, wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order linear equations to canonical forms.

• The Cauchy problem, Cauchy-Kowalewskaya theorem, Cauchy problem of finite and infinite string. Initial boundary value problems. Semi-infinite string with a fixed end, semi-infinite string with a free end. Equations with non-homogeneous boundary conditions. Non-homogeneous wave equation. Method of separation of variables, solving the vibrating string problem. Solving the heat conduction problem.

Unit-3:

Graphical Demonstration (Teaching Aid-Preferably by computer softwares)

The students will gain hands on expertise in graphical demonstration of the following, Using computer software or otherwise:

1. Plotting of a solution of Cauchy problem for first order PDE.
2. Plotting the characteristics for the first order PDE.
3. Plot the integral surfaces of a given first order PDE with initial data.
4. Plotting of a solution of wave equation for different initial and boundary conditions
5. Plotting of a solution of heat equation for different initial and boundary conditions**.**

6. Plotting of a solution of Laplace's equation for different initial and boundary conditions.

SEC Course-1(Logic and sets:Unit-1,2 & 3)

Learning Outcomes:

Introduction of logic and sets has been discussed. Students will learn about truth table, different propositions, predicates and quantifiers, various operations between two sets and logical equivalences etc in this course.

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• Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, Bi-conditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, quantifiers, binding variables and negations.
• Sets, subsets, set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. classes of sets. Power set of a set.
• 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.

Semester IV:

Core Course-8 (Multivariate Calculus & Vector Analysis:Unit-1,2, 3 & 4)
Unit-1 & 2: Multivariate Calculus
Learning Outcomes:
On completion of this course, the student will be able to
• Understand the concept of neighbourhood of a point in $R^n(n > 1)$, interior point, limit point, open set and closed set in $R^n(n > 1)$.
• Identify functions from $R^n(n > 1)$ to $R^m(m \geq 1)$.
Develop concepts on limit and continuity of functions of two or more variables, their partial derivatives, total derivative and differentiability, along with the sufficient condition for differentiability, Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes.
• Find Extrema of functions of two variables & understand the use of the method of Lagrange multipliers & solve constrained optimization problems.
Unit-3 & 4: Vector Analysis
Learning Outcomes:
After completion of this unit of the course which covers the following topics on multiple integrals, line integrals etc., the student will be able to apply these concepts to solve many real-life problems that may arise in different fields:
• Multiple integral: Concept of upper sum, lower sum, upper integral, lower integral and double integral (no rigorous treatment is needed). Statement of existence theorem for continuous functions. Iterated or repeated integral, change of order of integration. Triple integral. Cylindrical and Spherical coordinates. Change of variables in double integrals and triple integrals.

Transformation of double and triple integrals (problems only). Determination of volume and surface area by multiple integrals (problems only). Differentiation under the Integral sign, Leibniz's rule (problems only).

- Definition of vector field, divergence and curl. Line integrals, applications of line integral : 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.

Core Course-9 (Complex Analysis: Unit-1,2, 3 & 4)

Learning Outcomes:

Students will grasp the idea of complex functions, its derivatives and integrations. Also, in the practical classes, they will learn how to represent complex numbers, to find line integrals, contour integration, plotting of complex functions etc by using mathematical software.

Unit-1:

Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. Milne's method.

Unit-2:

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Antiderivatives, proof of antiderivative theorem, Cauchy-Goursat theorem, Cauchy integral formula.

Unit-3:

An extension of Cauchy integral formula, consequences of Cauchy integral formula.
Mobius transformations.

Unit-4:

Declaring a complex number e.g.$z_1 = 3 + 4i, z_2 = 4 - 7i$. Discussing their algebra
$z_1 + z_2,\ z_1 - z_2, z_1.z_2\ and\ \frac{z_1}{z_2}$ and then plotting them.

(ii) Finding conjugate, modulus and phase angle of an array of complex numbers.
(iii) Compute the integral over a straight line path between the two specified end points
(iv) Perform contour integration
(v) Plotting of the complex functions

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Core Course-10 (Ring theory, Linear Algebra & Metric spaces)

Learning Outcomes: Introduction of Ring theory should be the next step when the concepts of group theory has been build up. That's why, basic concepts of Ring theory and Metric spaces, further idea of inner product spaces and linear transformations have been introduced in this course.

Unit-1:

Ring theory: Definition and examples of rings, properties of rings, sub rings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, prime and maximal ideals, ring isomorphism(statement only).

Unit-2:

Linear algebra: Inner product space. Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphism, Isomorphism theorems, invertibility and isomorphism, change of coordinate matrix.

Unit-3:

Metric spaces: Definition and examples of Metric Spaces. Neighbourhoods. Limit points. Interior points. Open and closed sets. Closure and Interior. Boundary points. Subspace of Metric Space.
Cauchy Sequence. Completeness. Cantor Intersection Theorem. Construction of R as the completion of incomplete Metric Space Q (Deduction of no other completion process is required). Real number as a complete ordered field (No proof of the theorem).

SECCourse-2 (Graph theory:Unit-1,2 & 3)

Learning Outcomes:

Basic concepts of graphs, Eulerian circuits, Eulerian graphs, Hamiltonian cycles, representation of a graph by matrix etc. has been introduced in this course. Also, students shall learn the different applications of graph theory.

• 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
• Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm.

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Semester V:

Core Course-11(Probability and Statistics)

LearningOutcomes:

In this Course students will know about basic concepts on Probability and Statistics. Definition of Probability, Application of Bayes theorem, various probability functions and their applications, numerous measures to determine the nature of sampling data etc. have been discussed in this course.

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Unit 1 & 2 :

Random experiments, Simple and compound events. Event space. Classical and frequency definition of probability and their drawbacks. Axioms of Probability. Statistical regularity. Multiplication rule of Probabilities. Bayes' thorem. Independent events. Independent random experiments. Independent trials. Bernoulli trials and binomial law. Poisson trials. Random variables. Probability distribution. Distribution function. Discrete and continuous distributions. uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential. Mathematical expectation, mean, variance, moments, central moments, dispersion, skewness and kurtosis. Median, mode, quartiles, moment generating function, Characteristic function.

Unit- 3, 4 & 5:

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function and calculation of covariance, 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, Concept of population and Sampling. Sampling distribution of Statistic. Estimates of Population characteristic or parameter. Unbiased and consistent estimates. Sample characteristic as estimates of the corresponding population characteristic. Sampling distributions of the sample mean and variance. Exact sampling distributions for the normal population.

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CoreCourse-12 (Laplace Transform, Riemann Integration & Series of functions)

Learning Outcomes:

Theory and application of Laplace transformations, theory and concepts of Riemann integration and nature, convergence of series of functions and Fourier series will be discussed in this course.

Un**it 1** (**Laplace Transform:**)

Laplace of some standard functions, Existence conditions for the Laplace Transform, Shifting theorems, Laplace transform of derivatives and integrals, Inverse Laplace transform and their properties, Convolution theorem, Initial and final value theorem, Laplace transform of periodic functions, error functions, Heaviside unit step function and Dirac delta function, Applications of Laplace transform to solve ODEs.

Unit 2: Riemann integration and Improper integral

inequalities of upper and lower sums, Darboux integration, Darboux theorem, 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, properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorem of Integral Calculus. Improper integrals. Convergence of Beta and Gamma functions.

Unit 3 & 4: Series of functions and Fourier series

Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions. Theorems on the continuity, derivability and integrability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test. Fourier series, Trigonometric Fourier series and its convergence. Fourier series of even and odd functions, Fourier halfrange series.

DSE -1(Linear Programming and Game Theory)

Learning Outcomes:

In this course, the students will be able to learn about various optimization techniques pertaining to linear programming and apply linear programming to problems arising from real life. Also, the students will learn the basic concepts of game theory through a problem solving approach.

Unit 1:

Introduction to linear programming problem. Theory of simplex method, graphical solution, convex sets, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method. Big-M method and their comparison.

Unit 2:

Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

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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, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Unit 3:

Game theory: formulation of two person's zero sum game, solving two person zero sum game, games with mixed strategies, graphical solution procedure, dominance property, linear programming solution of games.

DSE-2 (Introduction to Integral equation and Dynamical system)

Learning Outcomes:

Preliminary idea about integral equation and dynamical system have been discussed here. The applications in real world problems have also been discussed in dynamical system.

Unit 1 & 2: Integral equations:

• Introduction and basic Examples. Classification, Conversion to Volterra Equation to ODE, Conversion of IVP and BVP to Integral equation, Decomposition, Direct Computation, Successive Approximation, Successive substitution method for Fredholm Integral equations.

• Series Solution. Successive approximation. Successive substitution method for Volterra integral equation. Volterra integral equation of first kind. Integral equation with separable kernel.

Unit 3 & 4: Dynamical System

• Formulation of physical system, Existence and uniqueness of solution of a dynamical system, linear system, solution of linear system, fundamental matrix, Fundamental matrices of non-autonomous system.

• Linear systems with periodic coefficients, stability of systems, stability of linear autonomous systems, stability of non-autonomous system using linearization, properties of orbit, phase portrait.

Semester VI:

Core Course-13(Dynamics of a particle)

Learning Outcomes:

In this course of study, students grab the basic knowledge of the behaviour of objects in motion. Motion in a straight line, Expressions of velocity and acceleration in different coordinate systems, central orbit, motion of a particle with varying mass and particle motion in a resisting medium are the key topics of this course.

Unit 1 &2:

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• Motion in straight line under variable acceleration. Simple Harmonic Motion. Hooke's law. Problems on elastic string. Expressions for velocity and acceleration of a particle moving on a plane in Cartesian and Polar coordinates.
• Motion of a particle moving on a plane with reference to a set of rotating axes.
• Central forces and central orbit.
• Tangential and normal accelerations. Circular motion. Simple cases of constrained motion of a particle. Motion of a particle in a plane under different laws of resistance. Motion of a projectile in a resisting medium.
• Trajectories in a resisting medium where resistance varies as some integral power of velocity. Terminal velocity. Motion under the inverse square law in a plane. Kepler's law and planetary motion. Escape velocity, time of describing an arc of an orbit, motion of artificial satellites.

Unit 3:

Equation of motion of a particle of varying mass. Problems of motion of varying mass such as those of falling raindrops and projected rockets.

Core Course-14(Numerical Methods)

Learning Outcomes:

This course will help students to understand the concept of error, various methods to find a root of an equation, solution of a system of linear equations, interpolation, numerical differentiation and integration etc. The students will also have hand on experience of the topic through computers using any software.

Unit 1&2:

• Errors: Relative, Absolute, Round off, Truncation.
• Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method. Rate of convergence of these methods.
• System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.
• Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation.

Unit 3:

Numerical Integration: Trapezoidal rule, Simpson's 1/3rd rule. Composite Trapezoidal rule, Composite Simpson's 1/3rd rule. Ordinary Differential Equationsµ Euler's method. Runge-Kutta method of orders two and four.

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Unit 4 :

1. Solution of transcendental and algebraic equations by
• Bisection method
• Newton Raphson method.
• Regula Falsi method.
2. Solution of system of linear equations
• Gaussian elimination method
• Gauss-Seidel method
3. Numerical Integration
• Trapezoidal Rule
• Simpson's one third rule
4. Solution of ordinary differential equations
• Euler method
• Runge- Kutta Method of orders two and four

DSE-3 (Number Theory)

Learning Outcomes:

Students will learn about number theory and the topic like congruences, Chinese remainder theorem, Fermat's little theorem, integer modulo n, Fermat's last theorem etc are key features of this course.

Unit 1, 2 & 3:

• Linear diophantine equation, The fundamental theorem of arithmetic, statement of prime number theorem, Goldbach conjecture, linear congruences, reduced and complete set of residues. Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.
• Number theoretic functions, sum and number of divisors, multiplicative and totally multiplicative functions, Mobius function, the Mobius inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, some properties of Euler's phi-function.
• 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 reciprocity, quadratic congruences with composite moduli. Pythagorean triple, primitive Pythagorean triple, Fermat's Last theorem.

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DSE-4 (Boolean algebra and discrete mathematics)

Learning Outcomes:

Preliminary idea about Boolean algebra and its implementation to modern day computers have been discussed here. Also, foundations of discrete Mathematics have been introduced in this course.

Unit 1 & 2:

Boolean Algebra: Huntington postulates for Boolean algebra, Algebra of sets and switching algebra as examples of Boolean Algebra, duality principle, Boolean functions, Normal forms, minimal and maximal forms of Boolean polynomials. Karnaugh maps, Design of switching circuits, Logic gates.

Unit 3 & 4 : Discrete Mathematics

• Discrete Mathematics: Principle of inclusion and exclusion, Pigeon-hole principle, Finite combinatorics, Generating functions, Partitions, Recurrence relations, Linear difference equations with constant coefficients.

• Partial and linear orderings, Chains and anti-chains, Lattices, Distributive lattices, Complementation, sub-lattices, products and homomorphisms.

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