DAV AUTONOMOUS COLLEGE,TITILAGARH

B.SC.(CORE) MATHEMATICS SYLLABUS

**SEM-I CORE-I CALCULUS-I FULL MARKS- INTERNAL-15+ PRACTICAL-25+SEM END EXAM-60**

**Unit-I**

Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of the type eax+b sin x; eax+b cos x; (ax + b)n sin x; (ax + b)n cos x; concavity and inflection 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 $∫$sin $nXdX$, $∫$cos$nXdX$, $∫$ tan$nX$ $dX$, $∫$ sec$nX$ $dX$, $∫$ (log x)n $dX$, $∫$ sinn $X$ cosn $XdX$, 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, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics. Sphere, Cone, Cylinder, Central Conicoids.

**Unit-IV**

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.

**Questions will be set covering all units. Five long questions carrying 12 marks and as option to the long question 2 or 3 (Two or Three) short questions carrying 6 or 4(Six or Four) marks will be asked**.

**SEM-I CORE-II ALGEBRA-I FULL MARKS- INTERNAL-20 SEM END EXAM-80**

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

**Unit-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, characterizations 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.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**SEM-II CORE-III: REAL ANALYSIS –I FULL MARKS- INTERNAL-20 SEM END EXAM-80**

**Unit-I**

Review of Algebraic and Order Properties of $R$; Neighborhood of a point in $R$; Idea of countable sets, uncountable sets and uncountability of $R$: Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima.

**Unit-II**

The Completeness Property of $R$; The Archimedean Property, Density of Rational(and Irrational) numbers in $R$, Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano Weierstrass theorem for sets.

**Unit-III**

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

**Unit-IV**

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchys $n$-th root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**SEM-II CORE-IV DIFFERENTIAL EQUATIONS**

**FULL MARKS- INTERNAL-15+ PRACTICAL-25+SEM END EXAM-60**

**Unit-I**

Differential equations and mathematical models. First order and first degree ODE (variables separable,

homogeneous, exact, and linear). Equations of first order but of higher degree. Applications of first order

differential equations(Growth, Decay and Chemical Reactions, Heat flow, Oxygen debt, Economics).

**Unit-II**

Second order linear equations(homogeneous and non-homogeneous) with constant coefficients, second

order equations with variable coefficients, variation of parameters, method of undetermined coefficients,

equations reducible to linear equations with constant coefficients, Euler's equation. Applications of

second order differential equations.

**Unit-III**

Power series solutions of second order differential equations.

**Unit-IV**

Laplace transforms and its applications to solutions of differential equations.

**Questions will be set covering all units. Five long questions carrying 12 marks and as option to the long question 2 or 3 (Two or Three) short questions carrying 6 or 4(Six or Four) marks will be asked**.

**Part-II(Practical)**

Practical/Lab work to be performed on a Computer.

1. Plotting of second order solution of family of differential equations.

2. Plotting of third order solution of family of differential equations.

3. Growth model (exponential case only).

4. Decay model (exponential case only).

5. Oxygen debt model.

6. Economic model.

7. Vibration problems.

**SEM-III CORE-V-: THEORY OF REAL FUNCTIONS (ANALYSIS-II) Full Marks- Internal-20 Sem End Exam-80**

**Unit-I**

Limits of functions ($\in $ − $δ $ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity.

**Unit-II**

Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem. Differentiability of a function at a point and in an interval, Caratheodorys theorem, algebra of differentiable functions.

**Unit-III**

Relative extrema, interior extremum theorem. Rolles theorem, Mean value theorem, intermediate value property of derivatives, Darbouxs theorem. Applications of mean value theorem to inequalities and approximation of polynomials, Taylors theorem to inequalities.

**Unit-IV**

Cauchys mean value theorem. Taylors theorem with Lagranges form of remainder, Taylors theorem with Cauchys form of remainder, application of Taylors theorem to convex functions, relative extrema. Taylors series and Maclaurins series expansions of exponential and trigonometric functions, ln (1 + $X$), 1/($aX$ + b) and (1 + $X$)n.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**SEM-III CORE-VI-3.2: GROUP THEORY(ALGEBRA-II) FULL MARKS- INTERNAL-20 SEM END EXAM-80**

**Unit-I**

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation 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, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of co-sets, Lagranges theorem and consequences including Fermats Little theorem.

**Unit-III**

External direct product of a finite number of groups, normal subgroups, factor groups, Cauchys theorem for finite abelian groups.

**Unit-IV**

Group homeomorphisms, properties of homeomorphisms, Cayleys theorem, properties of isomorphism’s, First, Second and Third isomorphism theorems.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**SEM-III CORE-VII: Partial Differential Equations and Systems of Ordinary Differential Equations**

**Full Marks- Internal-20 Sem End Exam-80**

**Unit-I**

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients(Two Equations in two unknown functions). Simultaneous linear first order equations in three variables, methods of solution, Pfaffian differential equations, methods of solutions of Pfaffian differential equations in three variables.

**Unit-II**

Formation of first order partial differential equations, Linear and non-linear partial differential equations of first order, special types of first-order equations, Solutions of partial differential equations of first order satisfying given conditions.

**Unit-III**

Linear partial differential equations with constant coefficients, Equations reducible to linear partial differential equations with constant coefficients, Partial differential equations with variable coefficients, Separation of variables, Non-linear equation of the second order.

**Unit-IV**

Laplace equation, Solution of Laplace equation by separation of variables, One dimensional wave equation, Solution of the wave equation(method of separation of variables), Diffusion equation, Solution of one-dimensional diffusion equation, method of separation of variables.

**Questions will be set covering all units. Five long questions carrying 12 marks and as option to the long question 2 or 3 (Two or Three) short questions carrying 6 or 4(Six or Four) marks will be asked**.

**Part-II(Practical):**

Practical Lab work to be performed on a Computer.

1. To find the general solution of the non-homogeneous system of the form:

$\frac{dx}{dt}$= a1x + b1y + ƒ1(t),$\frac{dy}{dt}$= a2x + b2y + ƒ2(t)

with given conditions.

2. Plotting the integral surfaces of a given first order PDE with initial data.

3. Solution of wave equation$ \frac{∂2u}{∂t2}$ – C2$ \frac{∂2u}{∂t2}$ =0 for the following associated conditions:

(a)$U$(x, 0) = $∅$(x), $U$t(x, 0) =$ψ$(x),x$\in $ $R$,t > 0. (b) $U$(x, 0) =$∅$(x), $U$t(x, 0) =$ψ$ (x)$U$x(0,t) =0,x$\in $(0,$\infty $),t > 0. (c) $U$(x, 0) = $∅$(x), $U$t(x, 0) =$ψ$ (x); u(0, t) = 0,x $\in $ (0,$\infty $), t > 0. (d)

$U$(x,0) = $∅$(x), $U$t(x, 0) =$ψ$ (x), $U$(0, t) = 0, u(1, t) = 0, 0 < x < $ι$, t > 0.

4. Solution of wave equation$\frac{∂u}{∂t} $**–** k2$ \frac{∂2u}{∂x2}$ = 0 for the following associated conditions:

(a) $U$(x, 0) = $∅$(x),$U$(0, t) = a, $U$($ι$, t) = b, 0 < x < $ι$; t > 0.

(b) $U$(x, 0) = $∅$(x), x $\in $ $R$, 0 < t < T.

(c) $U$(x,0) = $∅$(x), $U$(0, t) = a, x $\in $ (0,1), t $\geq $ 0.

**SEM-IV CORE -4.1: Numerical Methods Full Marks- Internal-20 Sem End Exam-80**

**Unit-I**

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Newtons method, Secant method. Rate of convergence of these

methods.

**Unit-II**

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

**Unit-III**

Interpolation: Lagrange and Newtons methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation.

**Unit-IV**

Numerical Integration: Trapezoidal rule, Simpsons rule, Simpsons 3/8th rule, Booles Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpsons rule. Ordinary Differential Equations: Eulers method. Runge Kutta methods of orders two and four.

**Questions will be set covering all units. Five long questions carrying 12 marks and as option to the long question 2 or 3 (Two or Three) short questions carrying 6 or 4(Six or Four) marks will be asked**.

**Part-II(Practical)**

Practical/Lab work to be performed on a Computer.

1. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + −−−−−−−−−−−−− +1/N:

2. To find the absolute value of an integer.

3. Enter 100 integers into an array and sort them in an ascending order.

4. Bisection Method.

5. Newton Raphson Method.

6. Secant Method.

7. Regulai Falsi Method.

8. LU decomposition Method.

9. Gauss-Jacobi Method.

10. SOR Method or Gauss-Siedel Method.

11. Lagrange Interpolation or Newton Interpolation.

12. Simpsons rule.

**SEM-IV CORE-4.2: Riemann Integration and Series of Functions (Analysis-III) Full Marks- Internal-20 Sem End Exam-80**

**Unit-I**

Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus.

**Unit-II**

Improper integrals; Convergence of Beta and Gamma functions.

**Unit-III**

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 and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.

**Unit-IV**

Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abels Theorem; Weierstrass Approximation Theorem.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**SEM-IV CORE-4.3: Ring Theory and Linear Algebra-I(Analysis-III) Full Marks- Internal-20 Sem End Exam-80**

**Unit-I**

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

**Unit-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 representation of a linear transformation, algebra of linear transformations. Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**SEM-V CORE-5.1: Multivariate Calculus (Calculus-II) Full Marks- Internal-20 Sem End Exam-80**

**Unit-I**

Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability and differentiability, 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. Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems, Definition of vector field, divergence and curl

**Unit-II**

Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems, Definition of vector field, divergence and curl.

**Unit-III**

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

**Unit-IV**

Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path. Greens theorem, surface integrals, integrals over parametrically defined surfaces. Stokes theorem, The Divergence theorem.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**SEM-V CORE-5.2: Probability and Statistics Full Marks- Internal-20 Sem End Exam-80**

**Unit-I**

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

**Unit-II**

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.

**Unit-III**

Expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

**Unit-IV**

Chebyshevs 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, Markov Chains, Chapman-Kolmogorov equations, classification of states.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**SEM-VI CORE -6.1: Metric Spaces and Complex Analysis (Analysis-IV) Full Marks- Internal-20 Sem End Exam-80**

**Unit-I**

Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantors theorem. Subspaces, dense sets, separable spaces. Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach Fixed point Theorem. Connectedness, connected subsets of $R$

**Unit-II**

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

**Unit-III**

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 module of contour integrals. Cauchy- Goursat theorem, Cauchy integral formula.

**Unit-IV**

Liouvilles theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**SEM-VI CORE -6.2: Linear Programming Full Marks- Internal-20 Sem End Exam-80**

**Unit-I**

Introduction to linear programming problem, Theory of simplex method, optimality and un-boundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two phase method, BigM method and their comparison.

**Unit-II**

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

**Unit-III**

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-IV**

Game theory: formulation of two persons zero sum games, solving two persons zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**SEM- Discipline Specific Electives -1 Programming in C++ (Compulsory)**

**Full Marks- Internal-20 Sem End Exam-80**

Introduction to structured programming: data types- simple data types, floating data types, character data types, string data types, arithmetic operators and operators precedence, variables and constant declarations, expressions, input using the extraction operator >> and cin, output using the insertion operator << and cout, preprocessor directives, increment(++) and decrement(−) operations, creating a C++ program, input/ output, relational operators, logical operators and logical expressions, if and if-else statement, switch and break statements. for, while and do-while loops and continue statement, nested control statement, value returning functions, value versus reference parameters, local and global variables, one dimensional array, two dimensional array, pointer data and pointer variables.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**Part-II(Practical)**

1. Calculate the Sum of the series

$\frac{1}{1}$ +$ \frac{1}{2}$ + $\frac{1}{3} $..+ $\frac{1}{N}$ for any positive integer N:

2. Write a user defined function to find the absolute value of an integer and use it to evaluate the function

(−1)n∕│n│, for n = −2, −1, 0, 1, 2.

3. Calculate the factorial of any natural number.

4. Read floating numbers and compute two averages: the average of negative numbers and the average of positive numbers.

5. Write a program that prompts the user to input a positive integer. It should then output a message indicating whether the number is a prime number.

6. Write a program that prompts the user to input the value of a; b and c involved in the equation ax2 + bx + c = 0 and outputs the type of the roots of the equation. Also the program should outputs all the roots of the equation.

7. write a program that generates random integer between 0 and 99: Given that first two Fibonacci numbers are 0 and 1; generate all Fibonacci numbers less than or equal to generated number.

8. Write a program that does the following:

a. Prompts the user to input five decimal numbers.

b. Prints the five decimal numbers.

c. Converts each decimal number to the nearest integer.

d. Adds these five integers.

e. Prints the sum and average of them.

9. Write a program that uses while loops to perform the following steps:

a. Prompt the user to input two integers : first Num and second Num (first Num should be less than second Num).

b. Output all odd and even numbers between first Num and second Num.

c. Output the sum of all even numbers between first Num and second Num.

d. Output the sum of the square of the odd numbers first Num and second Num.

e. Output all uppercase letters corresponding to the numbers between first Num and second Num, if any.

10. Write a program that prompts the user to input five decimal numbers. The program should then add the five decimal numbers, convert the sum to the nearest integer, and print the result.

11. Write a program that prompts the user to enter the lengths of three sides of a triangle and then outputs a message indicating whether the triangle is a right triangle or a scalene triangle.

12. Write a value returning function smaller to determine the smallest number from a set of numbers. Use this function to determine the smallest number from a set of 10 numbers.

13. Write a function that takes as a parameter an integer (as a long value) and returns the number of odd, even, and zero digits. Also write a program to test your function.

14. Enter 100 integers into an array and short them in an ascending/ descending order and print the largest/ smallest integers.

15. Enter 10 integers into an array and then search for a particular integer in the array.

16. Multiplication/ Addition of two matrices using two dimensional arrays.

17. Using arrays, read the vectors of the following type: A = (12345678), B = (02340156) and compute the product and addition of these vectors.

18. Read from a text file and write to a text file.

19. Write a function, reverse Digit, that takes an integer as a parameter and returns the number with its digits reversed. For example, the value of function reverse Digit 12345 is 54321 and the value of reverse Digit −532 is −235:

**SEM- DSE-II-Discrete Mathematics Full Marks- Internal-20 Sem End Exam-80**

**Unit-I**

Logic, proportional equivalence, predicates and quantifiers, nested quantifiers, methods of proof, relations and their properties, n-aray relations and their applications, Boolean functions and their representation. The basic counting, the Pigeon-hole principle, Generalized Permutations and Combinations.

**Unit-II**

Recurrence relations, Counting using recurrence relations, Solving linear homogeneous recurrence relations with constant coefficients, Generating functions, Solving recurrence relations using generating functions.

**Unit-III**

Partially ordered sets, Hasse diagram of partially ordered sets, maps between ordered sets, duality principle, Lattices as ordered sets, Lattices as algebraic structures, sublattices, Boolean algebra and its properties.

**Unit-IV**

Graphs: Basic concepts and graph terminology, representing graphs and graph isomorphism. Distance in a graph, Cut-vertices and Cut-edges, Connectivity, Euler and Hamiltonian path.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**2-Mathematical Modelling**

**Unit-I**

Simple situations requiring Mathematical modelling. The technique of Mathematical modelling, Mathematical modelling through differential equations, linear growth and decay models, non-linear growth and decay models, compartment models, Mathematical modelling of geometrical problems through ordinary differential equations of first order.

**Unit-II**

Mathematical modelling in population dynamics, Mathematical modelling of epidemics through systems of ordinary differential equations of first order, compartment models through systems of ordinary differential equations, Mathematical modelling in economics through systems of ordinary differential equations of first order.

**Unit-III**

Mathematical models in medicine, arms race, battles and international trade in terms of systems of ordinary differential equations, Mathematical modelling of planetary motions, Mathematical modeling of circular motion and motion of satellites, mathematical modelling through linear differential equations of second order.

**Unit-IV**

Situation giving rise to partial differential equations models, mass balance equations: First method of getting PDE models, momentum balance equations. The second method of obtaining partial differential models, variational principles , third function, fourth method of obtaining partial differential equation models, models for traffic flow of a highway. Situation that can be modelled through graphs, mathematical models in terms of directed graphs, optimization principles and techniques, Mathematical modeling through calculus of variations.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**3-Number Theory**

**Unit-I**

Divisibility theorem in integers, Primes and their distributions, Fundamental theorem of arithmetic, Greatest common divisor, Euclidean algorithms, Modular arithmetic, Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture.

**Unit-II**

Introduction to congruences, Linear Congruences, Chinese Remainder theorem, Polynomial congruences, System of linear congruences, complete set of residues, Chinese remainder theorem, Fermats little theorem, Wilsons theorem.

**Unit-III**

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mbius inversion formula, the greatest integer function, Eulers phifunction, Eulers theorem, reduced set of residues, some properties of Eulers phi-function.

**Unit-IV**

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Eulers criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**4-Boolean Algebra and Automata Theory**

**Unit-I**

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 forms of Boolean polynomials, QuinnMcCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

**Unit-II**

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

**Unit-III**

Context Free Grammars and Pushdown Automata: Context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties.

**Unit-IV**

Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence. Undecidability: Recursively enumerable and recursive languages, undecidable problems about Turing machines: halting problem, Post Correspondence Problem, and undecidability problems About CFGs.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**DSE-III**

**1-Differential Geometry**

**Unit-I**

Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae. Osculating circles, Osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves.

**Unit-II**

Osculating circles, Osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves.

**Unit-III**

Developables: Developable associated with space curves and curveson surfaces, Minimal surfaces.

**Unit-IV**

Theory of Surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms. Principal and Gaussian curvatures. Lines of curvature, Eulers theorem. Rodrigues formula, Conjugate and Asymptotic lines.

**2-Mechanics**

**Unit-I**

Moment of a force about a point and an axis, couple and couple moment, Moment of a couple about a line, resultant of a force system, distributed force system, free body diagram, free body involving interior sections, general equations of equilibrium, two point equivalent loading, problems arising from structures, static indeterminacy.

**Unit-II**

Laws of Coulomb friction, application to simple and complex surface contact friction problems, trans- mission of power through belts, screw jack, wedge, first moment of an area and the centroid, other centers, Theorem of Pappus-Guldinus, second moments and the product of area of a plane area, transfer theorems, relation between second moments and products of area, polar moment of area, principal axes.

**Unit-III**

Conservative force field, conservation for mechanical energy, work energy equation, kinetic energy and work kinetic energy expression based on center of mass, moment of momentum equation for a single particle and a system of particles.

**Unit-IV**

Translation and rotation of rigid bodies, Chasles theorem, general relationship between time derivatives of a vector for different references, relationship between velocities of a particle for different references, acceleration of particle for different references.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**3-Mathematical Finance**

**Unit-I**

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds.

**Unit-II**

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints), Two fund theorem, risk free assets, One fund theorem, capital market line, Sharpe index. Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensens index.

**Unit-III**

Forwards and futures, marking to market, value of a forward/futures contract, replicating portfolios, futures on assets with known income or dividend yield, currency futures, hedging (short, long, cross, rolling), optimal hedge ratio, hedging with stock index futures, interest rate futures, swaps.

**Unit-IV**

Lognormal distribution, Lognormal model / Geometric Brownian Motion for stock prices, Binomial Tree model for stock prices, parameter estimation, comparison of the models. Options, Types of options: put / call, European / American, pay o\_ of an option, factors affecting option prices, put call parity.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**4-Ring Theory and Linear Algebra-II**

**Unit-I**

Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in Z[x]:

**Unit-II**

Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.

**Unit-III**

Dual spaces, dual basis, double dual, transpose of a linear transformationand its matrix in the dual basis, annihilators, Eigenspaces of a linear operator, diagonalizability, invariant subspaces and Cayley- Hamilton theorem, the minimal polynomial for a linear operator.

**Unit-IV**

Inner product spaces and norms, Gram-Schmidt Orthogonalisation process, orthogonal complements, Bessels inequality, the ad-joint of a linear operator, Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-ad-joint operators, Orthogonal projections and Spectral theorem.

**DSE-IV**

**Project Work(Compulsory)**

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**Skill Enhancement Courses (SEC-I)**

**Communicative English and Writing Skill(Compulsory)**

**Skill Enhancement Courses (SEC-II)**

**1-Computer Graphics**

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, circle and ellipse generation, conic-section generation, polygon filling anti aliasing. Two-dimensional viewing: Coordinate systems, linear transformations, line and polygon clipping algorithms.

**2-Logic and Sets**

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, nary relations.

**3-Combinartorial Mathematics**

Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stiriling numbers Principle of Inclusion and Exclusion, Derangements, Inversion formulae Generating functions: Algebra of formal power series, Generating function models, Calculating generating functions, Exponential generating functions. Recurrence relations: Recurrence relation models, Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions. Integer partitions, Systems of distinct representatives.

**4-Information Security**

Overview of Security: Protection versus security; aspects of security-data integrity, data availability, privacy; security problems, user authentication, Orange Book. Security Threats: Program threats, worms, viruses, Trojan horse, trap door, stack and buffer over flow; system threats- intruders; communication threats- tapping and piracy. Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**Generic Electives/Interdisciplinary**

**GE-I: Calculus and Ordinary Differential Equations**

**Unit-I**

Curvature, Asymptotes, Tracing of Curves (Cartenary, Cycloid, Folium of Descartes, Astroid, Limacon, Cissoid & loops), Rectification, Quardrature, Volume and Surface area of solids of revolution.

**Unit-II**

Sphere, Cones and Cylinders, Conicoid.

**Unit-III**

Explicit and Implicit functions, Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylors theorem and Maclaurins theorem for functions of two variables. Maxima and Minima of functions of two and three variables, Implicit functions, Lagranges multipliers. Multiple integrals.

**Unit-IV**

Ordinary Differential Equations of 1st order and 1st degree (Variables separable, homogenous, exact and linear). Equations of 1st order but higher degree.

**Unit-V**

Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients, Variation of parameters. Laplace transforms and its applications to solutions of differential equations.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.

**GE-II: Linear Algebra and Advanced Algebra**

**Unit-I**

Vector space, Subspace, Span of a set, Linear dependence and Independence, Dimensions and Basis. Linear transformations, Range, Kernel, Rank, Nullity, Inverse of a linear map, Rank-Nullity theorem.

**Unit-II**

Matrices and linear maps, Rank and Nullity of a matrix, Transpose of a matrix, Types of matrices. Elementary row operations, System of linear equations, Matrix inversion using row operations, Determinant and Rank of matrices, Eigen values, Eigen vectors, Quadratic forms.

**Unit-III**

Group Theory: Definition and examples, Subgroups, Normal subgroups, Cyclic groups, Cosets, Quotient groups, Permutation groups, Homomorphism.

**Unit-IV**

Ring Theory: Definition and examples, Some special classes of Rings, Ideals, Quotient rings, Ring homomorphism. Isomorphism theorems.

**Unit-V**

Zero divisors, Integral domain, Finite fields, Finite field Z/pZ, Field of quotients of an Integral domain, Polynomial ring, Division algorithm, Remainder theorem, Factorization of polynomials, irreducible and reducible polynomials, Primitive polynomials, Irreducibility tests, Eisenstein Criterion.

**Questions will be set covering all units. Five long questions carrying 16 marks and as option to the long question 2 or 4(Two or Four) short questions carrying 8 or 4(Eight or Four) marks will be asked**.