CORE COURSES
B.Sc.(Honours)-Mathematics

Semester-I

C-1.1: Calculus-I
(Total Marks:100)

Part-I(Marks:75)
(Theory:60 Marks+Mid-Sem:15 Marks)

Unit-I

Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of the type $e^{ax+b} \sin x, e^{ax+b} \cos x, (ax+b)^n \sin x, (ax+b)^n \cos x$, concavity and 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 $\int \sin nx \, dx, \int \cos nx \, dx, \int \tan nx \, dx, \int \sec nx \, dx, \int (\log x)^n \, dx, \int \sin^n x \cos^n x \, dx$, volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution.

Unit-III

Techniques of sketching conics, 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.

Part-II(Practical, Marks:25)

List of Practicals (Using any software)
Practical/Lab work to be performed on a Computer.

1. Plotting the graphs of the functions $e^{ax+b}, \log(ax+b), 1/(ax+b), \sin(ax+b), \cos(ax+b), |ax+b|$ and to illustrate the effect of a and b on the graph.

2. Plotting the graphs of the polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.

3. Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid).

4. Obtaining surface of revolution of curves.

5. Tracing of conics in cartesian coordinates/polar coordinates.

6. Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, hyperbolic paraboloid using cartesian coordinates.

7. Matrix operation (addition, multiplication, inverse, transpose).
Books Recommended:


Books for Reference:


3. Text Book of Calculus, Part-II- Shantinarayan, S. Chand & Co.,

4. Text Book of Calculus, Part-III-Shantinarayan, S. Chand & Co.,


C-1.2: Algebra-I

Total Marks: 100

Theory: 80 Marks + Mid-Sem: 20 Marks

5 Lectures, 1 Tutorial (per week per student)

Unit-I

Polar representation of complex numbers, $n$-th roots of unity, De Moivre's 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 $\mathbb{R}^n$, dimension of subspaces of $\mathbb{R}^n$ and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Books Recommended:

1. L.V. Ahlfors, Complex Analysis, McGraw-Hill(International Student Edn.)

2. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006. Chapter: 2

3. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005. Chapters: 2(2.4), 3.4(4.1-4.1.6, 4.2-4.2.11, 4.4(4.1-4.4.8), 4.3-4.3.9, 5(5.1-5.1.4).

 Semester-II

C-2.1: Real Analysis (Analysis-I)
Total Marks:100
Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

Unit-I

Review of Algebraic and Order Properties of \( \mathbb{R} \), Neighborhood of a point in \( \mathbb{R} \), Idea of countable sets, uncountable sets and uncountability of \( \mathbb{R} \). Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima.

Unit-II

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

Unit-III


Unit-IV


Book Recommended:

1. G. Das and S. Pattanayak, Fundamentals of Mathematics Analysis, TMH Publishing Co. , Chapters: 2(2.1 to 2.4, 2.5 to 2.7), 3(3.1-3.5), 4(4.1 to 4.7, 4.10, 4.11,4.12, 4.13).

Books for References:

C-2.2: Differential Equations  
(Total Marks:100)

Part-I(Marks:75)  
Theory:60 Marks+Mid-Sem:15 Marks  
04 Lectures(per week per student)

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.

Part-II(Practical: Marks:25)

List of Practicals (Using any Software)

Practical/Lab work to be performed on a Computer.

1. Plotting of second order solution of family of differential equations.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Oxygen debt model.

Book Recommended:


Books for References:

3. G. Dennis Zill-A First Course in Differential Equations with Modelling Applications, Cengage Learning India Pvt. Ltd.
Semester-III
C-3.1: Theory of Real Functions (Analysis-II)
Total Marks:100
Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

Unit-I
Limits of functions (\(\epsilon - \delta\) 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, \(\ln(1+x), \frac{1}{(ax+b)}\) and \((1+x)^n\).

Book Recommended:

Books for References:

C-3.2: Group Theory(Algebra-II)
Total Marks:100
Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

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 cosets, 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 homomorphisms, properties of homomorphisms, Cayleys theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Book Recommended:

Books for References:

C-3.3: Partial Differential Equations and Systems of Ordinary Differential Equations
(Total Marks:100)

Part-I(Marks:75)
Theory:60 Marks+Mid-Sem:15 Marks
04 Lectures(per week per student)

Unit-I

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.

Part-II(Practical: Marks:25)

List of Practicals (Using any Software)

Practical/Lab work to be performed on a Computer.

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

\[
\frac{dx}{dt} = a_1x + b_1y + f_1(t), \quad \frac{dy}{dt} = a_2x + b_2y + f_2(t)
\]

with given conditions.

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

3. Solution of wave equation \( \frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0 \) for the following associated conditions:

   (a) \( u(x, 0) = \phi(x), u_t(x, 0) = \psi(x), x \in \mathbb{R}, t > 0 \).
   (b) \( u(x, 0) = \phi(x), u_t(x, 0) = \psi(x), u_x(0, t) = 0, x \in (0, \infty), t > 0 \).
   (c) \( u(x, 0) = \phi(x), u_t(x, 0) = \psi(x), u(0, t) = 0, x \in (0, \infty), t > 0 \).
   (d) \( u(x, 0) = \phi(x), u_t(x, 0) = \psi(x), u(0, t) = 0, u(1, t) = 0, 0 < x < l, t > 0 \).

4. Solution of wave equation \( \frac{\partial u}{\partial t} - k^2 \frac{\partial^2 u}{\partial x^2} = 0 \) for the following associated conditions:

   (a) \( u(x, 0) = \phi(x), u(0, t) = a, u(l, t) = b, 0 < x < l, t > 0 \).
   (b) \( u(x, 0) = \phi(x), x \in \mathbb{R}, 0 < t < T \).
   (c) \( u(x, 0) = \phi(x), u(0, t) = a, x \in (0, \infty), t \geq 0 \).

Book Recommended:

   Chapters:11, 12, 13(13.1-13.5), 15(15.1,15.5), 16(16.1, 16.1.1), 17(17.1, 17.2, 17.3).

Books for References:

Semester-IV
C-4.1: Numerical Methods
(Total Marks:100)

Part-I(Marks:75)
Theory:60 Marks+Mid-Sem:15 Marks
04 Lectures(per week per student)

Unit-I

Unit-II

Unit-III

Unit-IV

Part-II(Practical: Marks:25)
List of Practicals (Using any Software)
Practical/Lab work to be performed on a Computer.

1. Calculate the sum $\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \cdots + \frac{1}{N}$.

2. To find the absolute value of an integer.

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


7. Regulai Falsi Method.

8. LU decomposition Method.


10. SOR Method or Gauss-Siedel Method.

11. Lagrange Interpolation or Newton Interpolation.

12. Simpsons rule.
Note: For any of the CAS (Computer aided software) Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

Book Recommended:

1. B.P. Acharya and R.N. Das, A Course on Numerical Analysis, Kalyani Publishers, New Delhi, Ludhiana. Chapters: 1, 2(2.1 to 2.4, 2.6, 2.8, 2.9), 3(3.1 to 3.4, 3.6 to 3.8, 3.10), 4(4.1, 4.2), 5(5.1, 5.2, 5.3), 6(6.1, 6.2, 6.3, 6.10, 6.11), 7(7.1, 7.2, 7.3, 7.4 &7.7).


Books for References:


C-4.2: Riemann Integration and Series of Functions (Analysis-III)

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

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.

Book Recommended:

Books for References:
5. Shanti Narayan and M.D. Raisinghania-Elements of Real Analysis, S. Chand & Co. Pvt. Ltd.

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.

Book Recommended:

Books for References:
Semester-V

C-5.1: Multivariate Calculus (Calculus-II)
Total Marks:100
Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

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

Books Recommended:

Books for Reference:

C-5.2: Probability and Statistics
Total Marks:100
Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

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.

Books Recommended:

Books for References:
Semester-VI

C-6.1: Metric Spaces and Complex Analysis (Analysis-IV)

Total Marks: 100

Theory: 80 Marks + Mid-Sem: 20 Marks

5 Lectures, 1 Tutorial (per week per student)

Unit-I


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

Unit-IV


Books Recommended:


Books for References:

3. S. Ponnusamy-Foundations of Complex Analysis, Alpha Science International Ltd.
4. J.B. Conway-Functions of one complex variable, Springer.
C-6.2: Linear Programming  
Total Marks:100  
Theory:80 Marks+Mid-Sem:20 Marks  
5 Lectures, 1 Tutorial (per week per student)  

Unit-I  
Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, twophase method, BigM method and their comparison.  

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

Unit-III  

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

Recommended Books:  

Books for Reference:  
Discipline Specific Ecectives (DES)

DSE-1
Programming in C++ (Compulsory)
Part-I (Marks: 75)
(Theory: 60 Marks + Mid-Sem: 15 Marks)

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.

Book Recommended:

Books for References:

Part-II (Practical, Marks: 25)

List of Practicals (Using any software)
Practical/Lab work to be performed on a Computer.

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 $ax^2 + bx + c = 0$ 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 sort 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.


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 \(-235\).

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\textbf{DSE-II}
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\textbf{Total Marks:100}
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\textbf{Theory:80 Marks+Mid-Sem:20 Marks}
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\begin{center}
5 Lectures, 1 Tutorial (per week per student).
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(Any one of the following)
\begin{center}
1-Discrete Mathematics
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\textbf{Unit-I}
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Logic, proportional equivalence, predicates and quantifiers, nested quantifiers, methods of proof, rela-
tions and their properties, n-ary relations and their applications, Boolean functions and their representa-
tion. 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.

Book Recommended:

1. Kenneth H. Rosen, Discrete Mathematics and Applications, Tata McGraw Hill Publications, Chapters: 1(1.1 to 1.5), 4(4.1, 4.2, 4.5), 6(6.1, 6.2, 6.5, 6.6), 7(7.1, 7.2), 8,10(10.1,10.2).

Books for References:


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 modelling 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 modelling through calculus of variations.

Books Recommended:

1. J.N. Kapur-Mathematical Modelling, Chapters: 1(1.1 and 1.2), 2(2.1 to 2.4, 2.6), 3(3.1 to 3.5), 4(4.1 to 4.3), 6(6.1 to 6.6), 7(7.1 to 7.2), 9(9.1 and 9.2).

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 phi-function, 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.

Book Recommended:

1. D.M. Burton-Elementary Number Theory, McGraw Hill, Chapters: 2(2.1 to 2.4), 3(3.1 to 3.3), 4(4.1 to 4.4), 5(5.1 to 5.4), 6(6.1 to 6.3), 7(7.1 to 7.3), 8(8.1 to 8.2), 9(9.1 to 9.3).

Books for References:

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.

Books Recommended:

DSE-III
Total Marks: 100
Theory: 80 Marks + Mid-Sem: 20 Marks
5 Lectures, 1 Tutorial (per week per student.
(Any one of the following)

1-Differential Geometry

Unit-I


Unit-II


Unit-III

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

Unit-IV


Book Recommended:


Books for References


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, transmission 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.

Book Recommended:


Books for References:


2. Grant R Fowles, Analytical Mechanics, Cengage Learning India Pvt. Ltd.

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 off of an option, factors affecting option prices, put call parity.

Books Recommended:
1. David G. Luenberger, Investment Science, Oxford University Press, Delhi, 1998. Chapters: 1, 2, 3, 4, 6, 7, 8(8.5-8.8), 10(except 10.11, 10.12), 11(except 11.2 11.8).

Books for References:
2. Grant R Fowles, Analytical Mechanics, Cengage Learning India Pvt. Ltd.

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 \( \mathbb{Z}[x] \).

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 transformation and 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 adjoint of a linear operator, Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.

Books Recommended:
Books for References:
(For Linear Algebra)

1. S Lang, Introduction to Linear Algebra (2nd edition), Springer, 2005

(For Ring Theory)


DSE-IV
Project Work (Compulsory)
Total Marks: 100 (Project: 75 Marks + Viva-Voce: 25 Marks)
Skill Enhancement Courses(SEC)
(Credit: 2 each, Total Marks:50)
SEC-I to SEC-IV

SEC-I
Communicative English and Writing Skill(Compulsory)

SEC-II
(Any one of the following)

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.

Books Recommended:

2-Logic and Sets


Books Recommended:
3-Combinatorial Mathematics

Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling 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.

Books Recommended:


4-Information Security


Books Recommended:

Generic Electives/Interdisciplinary
(04 Papers, 02 papers each from two Allied disciplines)
(Credit: 06 each, Marks:100)
GE-I to GE-IV

GE-I: Calculus and Ordinary Differential Equations

Unit-I
Curvature, Asymptotes, Tracing of Curves (Cartenary, Cycloid, Folium of Descartes, Astroid, Limacon, Cissoid & loops), Rectification, Quadrature, 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.

Books Recommended:
4. Santosh K. Sengar-Advanced Calculus, Chapters: 2, 4, 5, 6, 7, 11, 12, 13.

Books for References:
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.

Books Recommended:

1. V. Krishnamurty, V. P. Mainra, J. L. Arora-An introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd., New Delhi, Chapters: 3, 4(4.1 to 4.7), 5(except 5.3), 6(6.1, 6.2, 6.5, 6.6, 6.8), 7(7.4 only).

Books for References:

5. I.N. Herstein-Topics in Algebra, Wiley Eastern Pvt. Ltd.