**COURSES OBJECTIVE AND OUTCOME**

**C1.1 Calculus**

Objective: After going through this course the students will be able to

1. Apply Calculus in real life problems
2. Formulate mathematical models

Outcome: Upon successful completion of this course, students will be able to

1. Describe the concepts and applications of derivatives and higher order derivatives
2. Understand the ideas of derivatives and higher order derivatives
3. Draw the graph of some curves using curve tracing
4. Illustrate the concept of area and volume with solid of revolution
5. Identify the rough sketch of curves in various coordinate systems
6. Develop reduction formulae
7. Evaluate integral values by appropriate reduction formula
8. Recognize scalar and vector functions

**C1.2 Algebra**

Objective: After going through this course the students will be able to

1. Describe various algebraic structures on sets
2. Identify the algebraic structures present in different branches of Sciences

Outcome: Upon successful completion of this course, students will be able to

1. Determine the properties of relations–reflexive, symmetric, transitive, and anti symmetric b. determine equivalence and partial order relations
2. Define and interpret the concepts of divisibility, congruence, greatest common divisor, prime and prime factorization.
3. solve a system of linear equations by row-reducing its augmented form and applications of linear system
4. Solve linear systems of equations using the language of matrices
5. List properties and subspaces of vectors in R^n
6. Find the characteristic equation, eigenvalues and corresponding eigenvectors of a given matrix

**C2.1 Real Analysis**

Objective: After going through this course the students will be able to

1. Identify the properties of the number system.
2. Describe various analytical properties of the real number system.

Outcome: Upon successful completion of this course, students will be able to

1. Describe the fundamental properties of the real numbers that underpin the formal development of real analysis
2. Determine if an infinite sequence is bounded, monotonic., convergent or divergent.
3. Determine if an infinite series is convergent or divergent by selecting the appropriate test from the following: (a) test for divergence; (b) integral test; (c) p-series test; (d) the comparison tests; (e) alternating series test; (f) absolute convergence test; (g) ratio test; and (h) root test.
4. Determine if an infinite series converges absolutely or conditionally

**C2.2 Differential Equations**

Objective: After going through this course the students will be able to

1. Use the techniques to solve differential equations.
2. Apply these techniques in various mathematical models used in real life problems.

Outcome: Upon successful completion of this course, students will be able to

1. Solve first order differential equations utilizing the standard techniques for separable, exact, linear, homogeneous, or Bernoulli cases.
2. Find existence and uniqueness of solutions.
3. Create and analyze mathematical models using higher order differential equations to solve application problems such as exponential decay, lake pollution, drug assimilation into the blood, growth of population etc.
4. Find the complete solution of a non-homogeneous differential equation as a linear combination of the complementary function and a particular solution.
5. Find the complete solution of a differential equation with constant coefficients by variation of parameters.
6. Apply these techniques to solve and analyze various Mathematical models.

**C3.1 Theory of Real Functions**

Objective: After going through this course the students will be able to

1. Discuss limit, continuity and differentiability of real valued functions
2. Expand functions in series and different form of remainders

Outcome: Upon successful completion of this course, students will be able to

1. Compare and contrast the ideas of continuity and differentiability
2. Understand the concepts uniform continuity.
3. Acquire the knowledge of Taylor’s series expansion for various functions and to use them to find maxima and minima, critical points and inflection points of functions and to determine the concavity of curves.
4. Understand the meaning of Rolle’s theorem, Darboux’s theorem, Mean value theorems etc. and their applications.

**C3.2 Group Theory I**

Objective: After going through this course the students will be able to

1. Describe various group structures on sets.
2. Indentify the group structures present in different branches of sciences.

Outcome: Upon successful completion of this course, students will be able to

1. Understand the importance of algebraic properties with regard to working within various number systems
2. Recognize the dihedral and symmetric groups when described using a standard form.
3. Decide whether a given group is cyclic, and given a finite cyclic group, find a generator for a subgroup of a given order
4. Verify that a given function is a homomorphism, Cayley’s theorem and various properties of isomorphism.
5. State and instantiate the definitions of the following terms: External direct product of two groups; internal direct product of two groups
6. Determine the kernel and image of a homomorphism.

**C3.3 PDE and Systems of ODE**

Objective: After going through this course the students will be able to

1. Make mathematical formulations and their solutions of various physical problems;
2. Design mathematical models used in heat, wave.
3. Describe the Laplace equation and their solutions.

Outcome: Upon successful completion of this course, students will be able to

1. Introduce students to partial differential equations.
2. Introduce students to how to solve linear Partial Differential with different methods.
3. To derive heat and wave equations in 2D and 3D.
4. Find the solutions of PDEs are determined by conditions at the boundary of the spatial domain and initial conditions at time zero.
5. Technique of separation of variables to solve PDEs and analyze the behavior of solutions in terms of eigen function expansions.
6. Understand to solve system of ODE, IVP using Euler’s method and Runge-Kutta method.

**C 4.1 Numerical Methods**

Objective: After going through this course the students will be able to

1. Discuss various numerical methods and interpolation formulae
2. Apply numerical techniques for solving differential equation.

Outcome: Upon successful completion of this course, students will be able to

1. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration.
2. Solve of linear and nonlinear equations, and the solution of differential equations.

**C4.2 Riemann Integration and Series of Functions**

Objective: After going through this course the students will be able to

1. Riemann integration, improper integrals.
2. Differentiation and integration of power series.

Outcome: Upon successful completion of this course, students will be able to

1. Understand Partition and refinement of partition of a closed and bounded interval.
2. Conceptualize Upper Darboux sum U(P, f) and lower Darboux sum L(P, f) and associated results. Upper integral and lower integral.
3. Understand Darboux’s theorem along with Darboux’s definition of integration over a closed and bounded interval.
4. Learn Riemann’s definition of integrability and its Equivalence with Darboux definition of integrability along with the Necessary and sufficient condition for Riemann integrability
5. Power series Fundamental theorem of power series. Cauchy-Hadamard theorem. Determination of radius of convergence. Uniform and absolute convergence of power series. Properties of sum function. Differentiation and integration of power series. Abel’s limit theorems. Uniqueness of power series having sum function.

**C4.3 Ring Theory and Linear Algebra I**

Objective: After going through this course the students will be able to

1. Describe various ring structures on sets.
2. Solve the system of linear equations

Outcome: Upon successful completion of this course, students will be able to

1. Write precise and accurate mathematical objects in ring theory
2. For checking the irreducibility of higher degree polynomials over rings.
3. To understand the concepts like ideals and quotient rings.
4. To understand the concept of ring homomorphism.

**C5.1 Multivariate Calculus**

Objective: After going through this course the students will be able to

1. Extend the concepts from one variable calculus to function of several variables
2. Demonstrate the ability to think critically and solving application of real world problems involving double/triple integrals.

Outcome: Upon successful completion of this course, students will be able to

1. Recognize mathematical formulas and methods of derivation of multivariable functions.
2. State the integration techniques to calculate multiple integrals in different coordinate systems.
3. Memorize the different theorems of vector calculus.
4. Perform differential calculus operations on functions of several variables including continuity, partial derivatives and directional derivatives.
5. Estimate multiple integrals in different coordinate systems including Cartesian, polar, cylindrical and spherical coordinates.
6. Perform calculus operations on vector-valued functions.
7. Apply the computational and conceptual principles of calculus to the solutions of various scientific applications.
8. Use the most important theorems of vector calculus, such as the Fundamental Theorem of Line Integrals, Green’s Theorem, the Divergence Theorem, and Stokes' Theorem, to simplify integration problems.

**C5.2 Group Theory II**

Objective: After going through this course the students will be able to

1. Apply results from preliminary concepts to solve contemporary problems.
2. Apply in communication theory, electrical engineering, computer science and cryptography

Outcome: Upon successful completion of this course, students will be able to

1. Apply the Internal Direct Product Theorem in simple cases
2. Decide whether a given group is cyclic, and given a finite cyclic group, find a generator for a subgroup of a given order
3. Express a given finite cyclic group as the direct product of cyclic groups of prime power order and, given two direct products of cyclic groups, determine whether or not they are isomorphic
4. Express products of elements of a group defined by generators and relations in appropriate standard form
5. Recognise the dihedral and dicyclic groups when described using a standard form.

**C6.1 Metric Spaces and Complex Analysis**

Objective: After going through this course the students will be able to

1. various properties of metrics paces
2. complex number system, its differentiation and integration

Outcome: Upon successful completion of this course, students will be able to

1. Learn various natural and abstract formulations of distance on the sets of usual

or unusual entities. Become aware one such formulations leading to metric spaces. Analyze how a theory advances from a particular frame to a general frame

1. Appreciate the mathematical understanding of various geometrical concepts, viz. balls or connected sets etc. in an abstract setting.
2. Learn about the two important topologicalproperties, namely connectedness and

Compactness of metric spaces.

1. Introduce elementary complex functions
2. Find parameterizations of curves, and compute complex line integrals directly
3. Evaluate integrals along a path in the complex plane and understand the statement of Cauchy's Theorem
4. Identify the isolated singularities of a function and determine whether they are removable, poles, or essential.
5. Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

**C6.2 Ring Theory and Linear Algebra II**

Objective: After going through this course the students will be able to

1. Apply theorems proof/ solution techniques to solve real world problems
2. Find the matrix associated with a linear transformation with respect to given bases and can understand the relationship between operations of linear transformations and corresponding matrices.

Outcome: Upon successful completion of this course, students will be able to

1. Appreciate the significance of unique factorization in rings and integral domains.
2. Compute the characteristic polynomial eigenvalues, eigenvectors, eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result
3. Compute inner products and determine orthogonality on vector spaces, including Gram−Schmidt orthogonalization to obtain orthonormal basis.
4. Find the adjoint, normal, unitary and orthogonal operators.

**DSE1.1 Analytical Geometry**

Objective: After going through this course the students will be able to

1. Sketch parabola, ellipse and hyperbola
2. Solve various geometrical problems analytically.

Outcome: Upon successful completion of this course, students will be able to

1. Introduction to analytical geometry of 2 dimensional.
2. Study of lines in 2 and 3 dimension
3. Finding equation in various form of line, circle, ellipse, sphere and quadratic surfaces like cone, ellipsoid etc.

**DSE2.1 Mathematical Modeling**

Objective: After going through this course the students will be able to

1. Solve differential equations and linear programming problems used in mathematical modeling.

Outcome: Upon successful completion of this course, students will be able to

1. Know about power series solution of a differential equation and learn about Legendre’s and Bessel’s equations.
2. Use of Laplace transform and inverse transform for solving initial value problems
3. Learn about various models such as Monte Carlo simulation models, queuing models, and linear programming models.
4. Know about geometric and algebraic solutions, simplex method and sensitivity analysis

**DSE2.2 Mechanics**

Objective: After going through this course the students will be able to

1. Describe Moment of a force and couple, general equation of equilibrium
2. Solve Problems of translation and rotation of rigid bodies

Outcome: Upon successful completion of this course, students will be able to

1. Know about the concepts in statics such as moments, couples, equilibrium in both two and three dimensions.
2. Understand the theory behind friction and center of gravity. Calculate moments of inertia of areas and rigid bodies.
3. Know about conservation of mechanical energy and work-energy equations.
4. Learn about translational and rotational motion of rigid bodies.

**DSE2.3 Number Theory**

Objective: After going through this course the students will be able to

1. Obtain solutions of Diophantine equations.
2. Define number theoretic functions.

Outcome: Upon successful completion of this course, students will be able to

1. Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach-conjecture etc.
2. Know about number theoretic functions and modular arithmetic.
3. Solve linear, quadratic and system of linear congruence equations.
4. Learn about public key crypto systems, in particular, RSA.

**DSE2.4 Bio-Mathematics**

Objective: After going through this course the students will be able to

1. Discuss various models and techniques to study Bio-mathematical real life problems.

 Outcome: Upon successful completion of this course, students will be able to

1. Learn the development, analysis and interpretation of bio mathematical models such as population growth, cell division, and predator-prey models.
2. Learn about the mathematics behind heartbeat model and nerve impulse transmission model.
3. Appreciate the theory of bifurcation and chaos.
4. Learn to apply the basic concepts of probability to molecular evolution and genetic.

**DSE3.2 Linear Programming**

Objective: After going through this course the students will be able to

1. Describe various optimization techniques pertaining to linear programming.
2. Apply linear programming to problems arising out of real life problems.

Outcome: Upon successful completion of this course, students will be able to

1. Learn about the graphical solution of linear programming problem with two variables.
2. Learn about the relation between basic feasible solutions and extreme points.
3. Understand the theory of the Simplex method used to solve linear programming problems.
4. Learn about two-phase and big-M methods to deal with problems involving artificial variables.
5. Learn about the relationships between the primal and dual problems.
6. Solve transportation and assignment problems.
7. Apply linear programming method to solve two-person zero-sum game problems.

**DSE 3.3 Discrete Mathematics**

Objective: After going through this course the students will be able to

1. Explain various discrete structures.
2. Design graph theoretic models of real life problems.

Outcome: Upon successful completion of this course, students will be able to

1. Understand the notion of ordered sets and maps between ordered sets.
2. Learn about lattices, modular and distributive lattices, sublattices and homomorphisms between lattices.
3. Become familiar with Boolean algebra, Boolean homomorphism, Karnaugh diagrams, switching circuits and their applications.
4. Learn about basics of graph theory, including Eulerian graphs, Hamiltonian graphs. Learn about the applications of graph theory in the study of shortest path algorithms.

**DSE3.4 Theory of Equations**

Objective: After going through this course the students will be able to

1. Discuss various properties of algebraic equations, symmetric properties of roots and determination of roots.

Outcome: Upon successful completion of this course, students will be able to

1. Describe the relation between roots and coefficients
2. Find the sum of the power of the roots of an equation using Newton’s Method.
3. Transform the equation through roots multiplied by a given number, increase the roots, decrease the roots, removal of terms
4. Solve the reciprocal equations.
5. Analyze the location and describe the nature of the roots of an equation.
6. Obtain integral roots of an equation by using Newton’s Method.
7. Compute a real root of an equation by Horner’s method.

**DSE 4.1 Mathematical Methods**

Objective: After going through this course the students will be able to

1. Construct mathematical models or real world problems.
2. Solve real world problems through the studied theories.

Outcome: Upon successful completion of this course, students will be able to

1. Know about piecewise continuous functions, Dirac delta function, Laplace transforms and its properties.
2. Solve ordinary differential equations using Laplace transforms.
3. Familiarize with Fourier transforms of functions belonging to 𝐿􀬵􁈺ℝ􁈻 class, relation between Laplace and Fourier transforms.
4. Explain applications of Fourier transforms to boundary value problems.
5. Learn Fourier series, Bessel’s inequality, term by term differentiation and integration of Fourier series.
6. Apply the concepts of the course in real life problems.

**DSE 4.2 Boolean Algebra and Automata Theory**

Objective: After going through this course the students will be able to

1. Define a lattice
2. Identify various lattice properties and apply them to describe switching circuits.

Outcome: Upon successful completion of this course, students will be able to

1. Define Semigroups, Monoids, Homomorphism and Isomorphism.
2. Describe the TF statements, connectives, atomic and compound statements.
3. Illustrate Tautology, Tautological implication, Truth Tables, Normal Forms, Principal Normal Forms.
4. Discuss the theory of inference, quantifiers, predicate calculus.
5. Interpret Lattices, Boolean Algebra, Karnaugh Map, Switching Circuits.

**DSE4.3 Probability and Statistics**

Objective: After going through this course the students will be able to

1. Characterize the statistical techniques.
2. Define various statistical distributions and obtain their related properties
3. Describe the mathematical theory of probability

Outcome: Upon successful completion of this course, students will be able to

1. Learn about probability density and moment generating functions.
2. Know about various univariate distributions such as Bernoulli, Binomial, Poisson, gamma and exponential distributions.
3. Learn about distributions to study the joint behavior of two random variables.
4. Measure the scale of association between two variables, and to establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.
5. Understand central limit theorem, which helps to understand the remarkable fact that**:** the empirical frequencies of so many natural populations, exhibit a bell-shaped curve, i.e., a normal distribution.

**DSE 4.4 Differential Geometry**

Objective: After going through this course the students will be able to

1. Describe various properties of space curves, surfaces and Geodesics
2. Discuss the properties of algebra and calculus of tensors.

Outcome: Upon successful completion of this course, students will be able to

1. Determine and calculate curvature of curves in different coordinate systems.
2. Parameterize surfaces and use the metric tensor. Calculate isometries.
3. Treat geodesic curves and parallel translation Calculate and analyze curvature of surfaces in different settings.
4. Know the concept of tensor and recognize tensors that are used in mechanics, image processing and theory of relativity.
5. Apply geometry of curves and surfaces to computer aided graphics
6. Discuss Gauss Bonnet theorem and its implication for a geodesic
7. Understand concepts of tensor variables and difference from scalar or vector variables.
8. Understand the reason why the tensor analysis is used and explain usefulness of the tensor analysis.
9. Derive base vectors, metric tensors and strain tensors in an arbitrary coordinate system.

**SEC-1.1 Logic and Sets**

Objective: After going through this course the students will be able to

1. Analyze the truth and falsity of a logical statement
2. Differentiate between a logical statement and an ordinary statement
3. Define and describe various properties of sets.

Outcome: Upon successful completion of this course, students will be able to

1. Analyze the logical structure of statements symbolically, including the proper use of logical connectives, predicates, and quantifiers.
2. Construct truth tables, prove or disprove a hypothesis, and evaluate the truth of a statement using the principles of logic
3. Solve problems and write proofs using the concepts of set theory, including the methods of Venn diagrams and truth tables.
4. Solve problems and write proofs using the basic definitions and the fundamental properties of subsets and operations on the real numbers, integers, rational and irrational, even and odd, multiples or factors of whole numbers

**SEC-1.2 Computer Graphics**

Objective: After going through this course the students will be able to

1. Indentify the core concepts of computer graphics
2. Apply graphics programming techniques to create and design computer graphics scans.

Outcome: Upon successful completion of this course, students will be able to

1. Understand the basic concepts and the functioning of graphic processors.
2. Implement various algorithms to scan, convert the basic geometrical transformations
3. Analyze graphics devices to produce a graphics image of desired quality.
4. Evaluate the utility of a certain graphics model by writing a program.

**SEC-2.1 Graph Theory**

Objective: After going through this course the students will be able to

1. Describe the fundamental properties of Graph Theory
2. Identify different representations of a Graph for practical applications

Outcome: Upon successful completion of this course, students will be able to

1. Understand graphs, paths, circuits which is very useful in daily life.
2. Find out shortest path by Travelling salesman’s problem & Dijkstra’s algorithm it is used in making travelling plan road maps, etc.

**SEC-2.2 Operating System: Linux**

Objective: After going through this course the students will be able to

1. Test the linux process model and explain how linux schedule processes and provide inter- process communication
2. Explore how linux implements files systems and manages input output devices.

Outcome: Upon successful completion of this course, students will be able to

1. Explain the structure and functions of operating systems along with their components, types and working.
2. Make use of appropriate Linux commands for memory management, file management and directory management.
3. Analyze the performance of different scheduling algorithms along with the policies for concurrency and deadlock management.
4. Elaborate the system calls for process management and file management.

**GE-1.1 Differential Calculus**

Objective: After going through this course the students will be able to

1. Differentiate functions
2. Find tangent normal, curvature, asymptotes etc.

Outcome: Upon successful completion of this course, students will be able to

1. Apply limiting properties to describe and prove continuity and differentiability conditions for real functions.
2. Understand important theorems, such as IVT, Rolle’s and Mean value theorem, and will begin the study of power series and convergence.
3. Learn methods of Tracing of curves in Cartesian, Parametric and Polar forms.

**GE-1.2 Object Oriented Programming in C++**

Objective: After going through this course the students will be able to

1. Write C-programmes to solve Mathematical problems.
2. Design algorithms to solve problems.

Outcome: Upon successful completion of this course, students will be able to

1. Able to Understand OOPs Concept ,C++ language features. Able to Understanding and Applying various Data types, Operators, Conversions in program design.
2. Able to Understand and Apply the concepts of Classes &Objects, friend function , constructors &destructors in program design.
3. Able to Design & implement various forms of inheritance, String class, calling base class constructors.
4. Able to Apply & Analyze operator overloading, runtime polymorphism , Generic Programming.
5. Able to Analyze and explore various Stream classes, I/O operations and exception handling.

**GE-2.1 Differential Equation**

Objective: After going through this course the students will be able to

1. Describe various methods for solving differential equations.

Outcome: Upon successful completion of this course, students will be able to

1. Explain the concept of differential equation.
2. solve first-order ordinary differential equations and higher-order linear differential equations.
3. Solves the homogeneous linear differential equations with constant coefficients. Applies the method of undetermined coefficients to solve the non-homogeneous linear differential equations with constant coefficients.

**GE-3.1 Real Analysis**

Objective: After going through this course the students will be able to

1. Analyze the properties of the number line
2. Describe various analytical properties of the real number syste

Outcome: Upon successful completion of this course, students will be able to

1. Understand many properties of the real line ℝ, including completeness and Archimedean properties.
2. Learn to define sequences in terms of functions from ℕ to a subset of ℝ.
3. Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
4. Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers

**GE3.2 Cryptography and Network Security**

Objective: After going through this course the students will be able to

1. Discuss the principles of Cryptography
2. Explain various ways of attacks in complex networks.
3. Explain the structure and organization of the complex network.

Outcome: Upon successful completion of this course, students will be able to

1. Understand the most common type of cryptographic algorithm.
2. Understand the Public-Key Infrastructure.
3. Understand security protocols for protecting data on networks · Be able to digitally sign emails and files.
4. Understand vulnerability assessments and the weakness of using passwords for authentication.
5. Perform simple vulnerability assessments and password audits.
6. Configure simple firewall architectures.
7. Understand Virtual Private Networks

**GE-4.1 Algebra**

Objective: After going through this course the students will be able to

1. Describe various algebraic structures onsets
2. Identify the algebraic structures present in different branches of Sciences

Outcome: Upon successful completion of this course, students will be able to

1. Understand the importance of algebraic properties with regard to working within various number systems
2. Recognize the dihedral and symmetric groups when described using a standard form.
3. Decide whether a given group is cyclic, and given a finite cyclic group, find a generator for a subgroup of a given order.