DEPARTMENT OF MATHEMATICS

Programme Outcome

PO1: This program helps the students to define mathematical concepts, calculate quantities, estimate solutions, solve problems.

PO2: This program helps to think in a critical manner.

PO3: This program helps to know when there is a need for information to be able to identify, locate, evaluate, and effectively use that information for the issue or problem at hand.

PO4: This program helps the Students to Acquire good knowledge and understanding in advanced areas of Mathematics and Statistics.

Programme Specific Outcome

Find employment utilizing their mathematical knowledge;
Use their mathematical knowledge to solve problems; and
Undertake further studies related to mathematics.

Based on these over-arching objectives, a set of program outcomes has been adopted which describe the skills, knowledge, attitudes, values and behaviors that students should be able to demonstrate by the time they complete the program. Specifically, students completing a mathematics major should:

- gain knowledge in foundational areas of mathematics;
- communicate mathematics accurately, precisely and effectively;
- develop mathematical thinking;
- apply mathematical knowledge; and
- be able to solve mathematical problems using technology.

Course Outcome

CO1: Applied Calculus

Solve systems of linear equations by use of the matrix,Compute limits, derivatives, and definite & indefinite integrals of algebraic, logarithmic and exponential functions,Analyze functions and their graphs as informed by limits and derivatives, andSolve applied problems using matrices, differentiation and integration.

CO2: Calculus

Compute limits and derivatives of algebraic, trigonometric, inverse trigonometric, exponential, logarithmic, and piece-wise defined functions;Compute definite and indefinite integrals of algebraic, trigonometric, inverse trigonometric, exponential, logarithmic, and piece-wise defined functions;Determine the continuity and differentiability of a function at a point and on a set;Use the derivative of a function to determine the properties of the graph of the function and use the graph of a function to estimate its derivative;Solve problems in a range of mathematical applications using the derivative or the integral;Apply the Fundamental Theorem of Calculus; andUse appropriate modern technology to explore calculus concepts. Define, graph, compute limits of, differentiate, and integrate transcendental functions,

CO3: Programming and Mathematical Problem Solving:

Write code using for/do loops, while constructions, conditional statements (if, then, else), and make use of logical constructs in the context of mathematics, Do basic 2- and 3-D plotting,Write code in the prescribed language for a number of algorithms for the topics covered given pseudo-code, or modify a given code to perform an indicated task,Create functions or subroutines,Debug code in the prescribed language at an appropriate level, and decide if they can make their code more efficient,Verify the correctness of a solution or decide whether the result is an acceptable approximation to the solution,Identify algorithms with which to solve mathematical problems, andWrite programs from the underlying algorithms, and demonstrate the ability to employ good commenting and coding techniques.

CO4: Linear Algebra and Linear Programming

Students will be able to set up and solve linear systems/linear inequalities graphically/geometrically and algebraically (using matrices).

CO5: Sets and Counting

Students will be able to formulate problems in the language of sets and perform set operations, and will be able apply the Fundamental Principle of Counting, Multiplication Principle.

CO6: Linear Algebra

Solve systems of linear equations,Analyze vectors in R^n geometrically and algebraically,Recognize the concepts of the terms span, linear independence, basis, and dimension, and apply these concepts to various vector spaces and subspaces,Use matrix algebra and the related matrices to linear transformations,Compute and use determinants,Compute and use eigenvectors and eigenvalues,Determine and use orthogonality, andUse technological tools

such as computer algebra systems or graphing calculators for visualization and calculation of linear algebra concepts.

CO7: Discrete Mathematics

Write and interpret mathematical notation and mathematical definitions,Formulate and interpret statements presented in Boolean logic. Reformulate statements from common language to formal logic. Apply truth tables and the rules of propositional and predicate calculus,Formulate short proofs using the following methods: direct proof, indirect proof, proof by contradiction, and case analysis,Demonstrate a working knowledge of set notation and elementary set theory, recognize the connection between set operations and logic, prove elementary results involving sets, and explain Russell's paradox,Apply the different properties of injections, surjections, bijections, compositions, and inverse functions,Solve discrete mathematics problems that involve: computing permutations and combinations of a set, fundamental enumeration principles, and graph theory, andGain an historical perspective of the development of modern discrete mathematics.

CO8: Number Theory

Define and interpret the concepts of divisibility, congruence, greatest common divisor, prime, and prime-factorization,Apply the Law of Quadratic Reciprocity and other methods to classify numbers as primitive roots, quadratic residues, and quadratic non-residues,Formulate and prove conjectures about numeric patterns, andProduce rigorous arguments (proofs) centered on the material of number theory, most notably in the use of Mathematical Induction and/or the Well Ordering Principal in the proof of theorems.

CO9: Real Analysis

Describe the real line as a complete, ordered field,Determine the basic topological properties of subsets of the real numbers,Use the definitions of convergence as they apply to sequences, series, and functions,Determine the continuity, differentiability, and integrability of functions defined on subsets of the real line,Apply the Mean Value Theorem and the Fundamental Theorem of Calculus to problems in the context of real analysis, andProduce rigorous proofs of results that arise in the context of real analysis.Write solutions to problems and proofs of theorems that meet rigorous standards based on content, organization and coherence, argument and support, and style and mechanics.

CO10: Differential Equations

Solve differential equations of first order using graphical, numerical, and analytical methods,Solve and apply linear differential equations of second order (and higher),Solve linear differential equations using the Laplace transform technique,Find power series solutions of differential equations, andDevelop the ability to apply differential equations to significant applied and/or theoretical problems Theory of Ordinary Differential Equations, a student will be able to:Solve problems in ordinary differential equations, dynamical systems, stability theory, and a number of applications to scientific and engineering problems,Demonstrate their ability to

write coherent mathematical proofs and scientific arguments needed to communicate the results obtained from differential equation models,Demonstrate their understanding of how physical phenomena are modeled by differential equations and dynamical systems,Implement solution methods using appropriate technology, andInvestigate the qualitative behavior of solutions of systems of differential equations and interpret in the context of an underlying model.

CO11: Linear Programming and Operations Research

Formulate and model a linear programming problem from a word problem and solve them graphically in 2 and 3 dimensions, while employing some convex analysis,Place a Primal linear programming problem into standard form and use the Simplex Method or Revised Simplex Method to solve it,Find the dual, and identify and interpret the solution of the Dual Problem from the final tableau of the Primal problem,Be able to modify a Primal Problem, and use the Fundamental Insight of Linear Programming to identify the new solution, or use the Dual Simplex Method to restore feasibility,Interpret the dual variables and perform sensitivity analysis in the context of economics problems as shadow prices, imputed values, marginal values, or replacement values,Explain the concept of complementary slackness and its role in solving primal/dual problem pairs,Classify and formulate integer programming problems and solve them with cutting plane methods, or branch and bound methods, andFormulate and solve a number of classical linear programming problems and such as the minimum spanning tree problem, the assignment problem, (deterministic) dynamic programming problem, the knapsack problem, the XOR problem, the transportation problem, the maximal flow problem, or the shortest-path problem, while taking advantage of the special structures of certain problems.

CO12: Topology

Define and illustrate the concept of topological spaces and continuous functions,Define and illustrate the concept of product topology and quotient topology,Prove a selection of theorems concerning topological spaces, continuous functions, product topologies, and quotient topologies,Define and illustrate the concepts of the separation axioms,Define connectedness and compactness, and prove a selection of related theorems, andDescribe different examples distinguishing general, geometric, and algebraic topology.

CO13: Probability and Applied Statistics

Recognize the role of and application of probability theory, descriptive and inferential statistics in many different fields,Define, illustrate, and apply the concepts of probability and conditional probability,Define, illustrate, and apply the concepts of discrete and continuous random variables,Define, illustrate, and apply the concept of expectation to the mean, variance, and covariance of random variables,Identify and demonstrate appropriate sampling and data collection processes, classification of variables, and graphical summaries,Apply parametric testing techniques including single and multi-sample tests for mean and proportion and regression, andUse statistical software for probability simulations and data analysis.

CO14: Numerical Analysis

Derive numerical methods for approximating the solution of problems of continuous mathematics,Analyze the error incumbent in any such numerical approximation,Implement a variety of numerical algorithms using appropriate technology, andCompare the viability of different approaches to the numerical solution of problems arising in roots of solution of non-linear equations, interpolation and approximation, numerical differentiation and integration, solution of linear systems.

CO15: Vector Analysis

Scalar and cross product of vectors in 2 and 3 dimensions represented as differential forms or tensors,The vector-valued functions of a real variable and their curves and in turn the geometry of such curves including curvature, torsion and the Frenet-Serre frame and intrinsic geometry,Scalar and vector valued functions of 2 and 3 variables and surfaces, and in turn the geometry of surfaces,Gradient vector fields and constructing potentials,Integral curves of vector fields and solving differential equations to find such curves,The differential ideas of divergence, curl, and the Laplacian along with their physical interpretations, using differential forms or tensors to represent derivative operations,The integral ideas of the functions defined including line, surface and volume integrals - both derivation and calculation in rectangular, cylindrical and spherical coordinate systems and understand the proofs of each instance of the fundamental theorem of calculus, andExamples of the fundamental theorem of calculus and see their relation to the fundamental theorems of calculus in calculus 1, leading to the more generalised version of Stokes' theorem in the setting of differential forms.

CO16: Complex Analysis

Represent complex numbers algebraically and geometrically,Define and analyze limits and continuity for complex functions as well as consequences of continuity,Apply the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions including the fundamental theorem of algebra,Analyze sequences and series of analytic functions and types of convergence,Evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula, andRepresent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

CO17: Partial Differential Equations

Be familiar with the modeling assumptions and derivations that lead to PDEs,Recognize the major classification of PDEs and the qualitative differences between the classes of equations, andBe competent in solving linear PDEs using classical solution methods.

CO18: Graph theory

Students will be able to model and solve real-world problems using graphs and trees, both quantitatively and qualitatively.