DEPARTMENT OF MATHEMATICS

PROGRAM OUT COME

- By the end of a B Sc program, a student will:

- PO1: Be able to analyze, test, interpret and form independent judgments in both academic and non-academic contexts.
- PO2: Recognize and appreciate the connections between theory and applications.
- PO3: Have an appropriate set of professional skills to ensure a productive career.
- PO4: Work effectively in a multi-disciplinary environment.
- PO5: Be prepared for life-long learning.
- PO6: Exhibit positive attitudes and values toward the discipline, so that they can contribute to an increasingly complex and dynamic society.
- PO7: Develop effective communication skills in English and regional / national language.
- PO8: Communicate effectively with whom they are interacting and the society to make effective presentations, and give and receive clear instructions.
- PO9: Function effectively as an individual, and as a member or leader in diverse teams.

SPECIFIC OUT COME

- Program Specific Outcomes By the end of B Sc program in Mathematics, a student will: PSO1: Be familiar with different areas of Mathematics.
- PSO2: Construct abstract models using appropriate mathematical and statistical tools.
- PSO3: Be prepared to use Mathematics, not only in the discipline of Mathematics, but also in other disciplines and in their future endeavors.
- PSO4: Recognize what constitutes mathematical thinking, including the ability to produce and judge the validity of rigorous mathematical arguments.
- PSO5: Identify suitable existing methods of analysis, if any, and assess his/her strengths and weaknesses in the context of the problem being considered.
- PSO6: Develop the skills necessary to formulate and understand proofs and to provide justification.
- PSO7: Think critically and communicate clearly mathematical concepts and solutions to real-world problems.
- PSO8: Be able to solve problems using a broad range of significant mathematical techniques. PSO9: Engage his/her creativity in the quest for novel or elegant solutions.

- PSO10: Develop an understanding of the precise language of Mathematics, and be able to integrate mathematical arguments with their critical thinking skills.
- PSO11: Be a life-long learner who is able to independently expand his/her mathematical or statisttical expertise when needed.

SUBJECT WISE OUTCOMES

DEPARTMENT OF MATHEMATICS

FOUNDATION OF MATHEMATICS

Course Outcomes :

- Upon completion of this course, students should be able to:
- CO1: Apply the logic theory to practical situations for drawing conclusions
- CO2: Analyze statements using truth tables
- CO3: Write and interpret mathematical notation and mathematical definitions
- CO4: Construct and restate various theorems using logical arguments
- CO5: Unravel abstract definitions, create intuition-forming examples or counterexamples, and prove conjectures
- CO6: Formulate short proofs using the following methods: direct proof, indirect proof, proof by contradiction, and case analysis
- CO7: Apply the logical structure of proofs and work symbolically with connectives and quantifiers to produce logically valid, correct and clear arguments
- CO8: Write solutions to problems and proofs of theorems that meet rigorous standards based on content, organization and coherence, argument and support
- CO9: Understand the basic theory of sets, perform set operations on finite and infinite collections of sets and be familiar with properties of set operations
- CO10: Explain the fundamental ideas of sets and functions

ANALYTIC GEOMETRY, TRIGONOMETRY AND DIFFERENTIAL CALCULUS

Course Outcomes

- Upon completion of this course, students should be able to:
- CO1: Understand how to analyze and synthesize given data to solve problems in geometry CO2: Understand the basic ideas of conics
- CO3: Explain the ideas of conics and their various applications
- CO4: Find the equation to tangent, normal at a point on a conic
- CO5: Apply the properties of conics to solve problems in real life situations
- CO6: Explain the ideas of conics to explain many natural phenomenon

- CO7: Find the polar equation of a line, circle, tangent and normal to conics
- CO8: Acquire the basic knowledge of Circular and Hyperbolic Functions of a Complex Variable
- CO9: Familiarized with real and imaginary parts of a circular and hyperbolic functions of a complex variable
- CO10: Distinguish between the various methods for separating complex numbers in various forms into real and imaginary parts

VECTOR CALCULUS, THEORY OF NUMBERS AND LAPLACE TRANSFORM

Course Outcomes :

- Upon completion of this course, students should be able to:
- CO1: cquire the basic knowledge of vector differentiation and vector integration
- CO2: Determine and apply, the important quantities associated with scalar fields, such as partial derivatives of all orders, the gradient vector and directional derivative
- CO3: Determine and apply, the important quantities associated with vector fields such as the divergence, curl, and scalar potential
- CO4: Calculate line integrals along piecewise smooth paths; interpret such quantities as work done by a force
- CO5: Evaluate line, surface, double and triple integrals and use these integrals to verify the seminal integral theorems (Green's theorem in the plane, Gauss' divergence theorem and Stokes' theorem)
- CO6: Apply vector algebra techniques to analyze problems involving two and three dimensional entities – lines, curves, planes and surfaces
- CO7: Use Green's theorem to evaluate line integrals along simple closed contours on the plane
- CO8: Compute the curl and the divergence of vector fields
- CO9: Employ the techniques of the higher dimensional differential calculus in problems of physical interest
- CO10: Compute the area of parametric surfaces in 3-dimensional space

DIFFERENTIAL EQUATIONS

Course Outcomes :

- Upon completion of this course, students should be able to:
- CO1: Identify, analyze and subsequently solve physical situations whose behavior can be described by ordinary differential equations

- CO2: Understand the order, degree and various standard forms of differential equations CO3: Determine solutions to first order separable differential equations
- CO4: Determine solutions to first order linear differential equations
- CO5: Explain an integrating factor, which may reduce the given differential equation into an exact one and eventually provide its solutions
- CO6: Familiarize the orthogonal trajectory of the system of curves on a given surface
- CO7: Determine solutions to first order exact differential equations
- CO8: Determine solutions to second order linear homogeneous differential equations with constant coefficients
- CO9: Understand the basic knowledge of complimentary function and particular integral CO10: Determine solutions to second order linear non-homogeneous differential equations with constant coefficients

ABSTRACT ALGEBRA

Course Outcomes :

- Upon completion of this course, students should be able to:
- CO1: Demonstrate understanding of and the ability to verify relationships between operations satisfying various properties (e.g. commutative property)
- CO2: Demonstrate understanding of and the ability to work within various algebraic structures
- CO3: Assess properties implied by the definitions of groups and rings
- CO4: Acquire the basic knowledge and the structure of Group, Subgroup and Cyclic Groups CO5: Explain the significance of the notion of a normal subgroup, and of a simple group
- CO6: Analyze and demonstrate examples of subgroups, normal subgroups and quotient groups
- CO7: Use Lagrange's Theorem to analyze the cyclic subgroups of a group
- CO8: Acquire the notion of permutations and operations on them
- CO9: Prove Cayley's theorem and understand its applications
- CO10: Explain the terms isomorphism and homomorphism

Real Analysis

Course Outcomes :

- Upon completion of this course, students should be able to:
- CO1: Explain Continuity and Discontinuity of various functions in different contexts
- CO2: Differentiate Uniform continuity from continuity and related theorems

- CO3: Understand the meaning of derivative of a function
- CO4: Acquire skill in applying the various techniques of differentiation and applications
- CO5: Understand theorems associated with differentiability
- CO6: Gain knowledge of L' Hospital Rule and evaluation of limits
- CO7: Expand functions using Taylor Series
- CO8: Understand partitions and their refinement
- CO9: Understand Integrability and theorems on integrability
- CO10: Acquire the idea about Riemann Integrability and Riemann Integration

GRAPH THEORY AND METRIC SPACES

Course Outcomes :

- Upon completion of this course, students should be able to:
- CO1: Acquire a basic idea of graph, various terms associated and matrix representations of graphs
- CO2: Familiarize with different types of graphs, connectivity and properties
- CO3: Illustrate the fundamental applications of Graph Theory in different walks of life
- CO4: Understand trees and their properties
- CO5: Identify vertices, edges and paths with specific properties such as cut vertices, bridges, Eulerian, etc
- CO6: Check for solutions of famous basic problems in graph theory such as Utility Problem, Travelling Salesman Problem, Chinese Postman Problem etc
- CO7: Understand the basic concepts of open sets, closed sets, Cantor sets and metric spaces CO8: Understand the various properties of metric spaces
- CO9: Become familiar with convergence in metric spaces and theorems on convergence CO10: Explore various properties of complete metric spaces and relate them with convergence of sequences

Complex Analysis

Course Outcomes :

- Upon completion of this course, students should be able to:
- CO1: Compute sums, products, quotients, conjugate, modulus, and argument of complex numbers
- CO2: Write complex numbers in polar form
- CO3: Introduce elementary complex functions

- CO4: Find all integral roots and all logarithms of nonzero complex numbers
- CO5: Evaluate exponentials and integral powers of complex numbers
- CO6: Define and analyze limits and continuity for complex functions as well as consequences of continuity
- CO7: Determine whether a given function is differentiable, and if so find its derivative
- CO8: Use differentiation rules to compute derivatives
- CO9: Understand the significance of differentiability for complex functions and be familiar with the Cauchy-Riemann equations
- CO10: Conceive the concepts of analytic functions and will be familiar with the elementary complex functions and their properties

Linear Algebra

Course Outcomes :

- Upon completion of this course, students should be able to:
- CO1: Acquire the knowledge of a matrix, basic operations, rank and determinant of a matrix CO2: Understand the various applications of the theory of matrices to a wide variety of problems
- CO3: Understand various methods for determining rank of a matrix
- CO4: Acquire knowledge of invertible matrices and their properties
- CO5: Recognize the concepts of the terms span, linear independence, basis, dimension, and apply these concepts to various vector spaces and subspaces
- CO6: Introduce the new terms Basis and Dimension
- CO7: Acquire the knowledge of ordered basis
- CO8: Analyze vectors in Rn geometrically and algebraically
- CO9: Analyze finite and infinite dimensional vector spaces and subspaces over a field and their properties, including the basis structure of vector spaces
- CO10: Solve a System of Linear equations using the inverse of a matrix

OPERATIONS RESEARCH

Course Outcomes :

- Upon completion of this course, students should be able to:
- CO1: Define a LPP in standard form and Canonical form
- CO2: Identify a feasible solution, a basic feasible solution and an optimal solution using simplex method
- CO3: Understand the new term LPP

- CO4: 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
- CO5: Place a Primal linear programming problem into standard form and use the Simplex Method or The Big M Method to solve it
- CO6: Formulate 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 transportation problem, the maximal flow problem, or the shortest-path problem, while taking advantage of the special structures of certain problems CO7: Use dual simplex method to find optimal solutions CO8: Understand duality theorems and dual simplex method
- CO9: Identify the advantages of duality method
- CO10: Apply the theorems on duality to problems appropriately

Statistics:

Programme Learning Outcomes in (General) :

- The student graduating with the Degree (General) Statistics should be able to
- Demonstrate the ability to use skills in Statistics and different practicing areas for formulating and tackling Statistics related problems and identifying and applying appropriate principles and methodologies to solve a wide range of problems associated with Statistics.
- Acquire (i) fundamental/systematic or coherent understanding of the academic field of Statistics and its different learning areas and applications. UGC DOCUMENT ON LOCF STATISTICS 8 (ii) procedural knowledge that creates different types of professionals related to subject area of Statistics, including professionals engaged in government/public service and private sectors; (iii) skills in areas related to one's specialization area within the disciplinary/subject area of Statistics and emerging developments in the field of Statistics.
- Recognize the importance of statistical modeling and computing, and the role of approximation and mathematical approaches to analyze the real problems using various statistical tools.
- Plan and execute Statistical experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate statistical software including programming languages, and report accurately the findings of the experiment/investigations.
- Demonstrate relevant generic skills and global competencies such as (i) problem-solving skills that are required to solve different types of Statisticsrelated problems with well-defined solutions, and tackle open-ended problems that belong to the disciplinary-area boundaries; (ii) investigative skills, including skills of independent

thinking of Statistics-related issues and problems; (iii) communication skills involving the ability to listen carefully, to read texts and reference material analytically and to present information in a concise manner to different groups/audiences of technical or popular nature; (iv) analytical skills involving paying attention to detail and ability to construct logical arguments using correct technical language related to Statistics and ability to translate them with popular language when needed; (v) ICT skills; (vi) personal skills such as the ability to work both independently and in a group.

- Demonstrate professional behavior such as (i) being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behavior such as fabricating, falsifying or misrepresenting data or committing plagiarism; (ii) the ability to identify the potential ethical issues in work-related situations; UGC DOCUMENT ON LOCF STATISTICS 9 (iii) appreciation of intellectual property, environmental and sustainability issues; and (iv) promoting safe learning and working environment.

Numerical methods

Course Specific Objectives :

- Learning outcomes:
- Successful completion of this course should lead to the following learning outcomes for each student:
- Knowledge and understanding:
- A1) List theories and concepts used in Numerical Analysis.
- A2) Identify the steps required to carry out a piece of research on a topic within Numerical Analysis.
- A3) Recognize the contribution and impacts of Numerical Analysis in real life problem.
- Intellectual skills:
- B1) Apply appropriate theories, principles and concepts relevant to the numerical analysis.
- B2) Formulate a reasoned argument from a variety of sources relevant to Numerical Analysis.
- B3) Analyze and interpret information from a variety of sources relevant to Numerical Analysis.
- B4) Select a reasoned argument to the solution of familiar and unfamiliar problems relevant to Numerical Analysis.
- Professional skills:
- C1) Plan practical activities using techniques and procedures appropriate to Numerical Analysis.
- C2) Design a piece of independent research using Numerical Analysis.

- General skills:
- D1) Think independently, Set tasks and solve problems on ethical scientific basis relevant to Numerical Analysis.
- D2) Communicate with others positively as part of a group, involving leadership, group dynamics and interpersonal skills such as listening, negotiation and persuasion relevant to Numerical Analysis.
- D3) Use information and communication technology to discuss problems relevant to Numerical Analysis

MECHANICS

Learning outcomes:

- Students will be able to articulate and describe:
- 1. Relative motion. Inertial and non inertial reference frames.
- 2. Parameters defining the motion of mechanical systems and their degrees of freedom. 3. Study of the interaction of forces between solids in mechanical systems.
- 4. Centre of mass and inertia tensor of mechanical systems.
- 5. Application of the vector theorems of mechanics and interpretation of their results. 6 Newton's laws of motion and conservation principles.
- 7. Introduction to analytical mechanics as a systematic tool for problem solving.
- 8. Use of mechanical simulation software.