# RAJA PEARY MOHAN COLLEGE

## Department of Mathematics

### B.Sc. Honours in Mathematics

Programe Specific Outcome, Course Outcome, Programe Outcome

(PSO, CO, PO)

**Annexure -I**

**PO, PSO, CO of UG program in Mathematics as major subject**

**Program Outcomes**

**By the end of a B. Sc. program with Mathematics as major or minor subject, 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

## Program Specific Outcomes

## By the end of B. Sc. program in Mathematics as a major subject, 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 statistical expertise when needed

## Semester I

## CC1 & CC2: Calculus, Geometry, Vector Analysis & Algebra

**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

CO11: Establish the relationship between various variables existing in a system

CO12: Determine equivalence relations on sets and corresponding equivalence classes

CO13: Differentiate between various types of functions

CO14: Work with functions and in particular bijections, direct and inverse images and inverse functions

CO17: To introduce the concept of a dependent variable depending on more than two dependent variables and finding partial derivatives

CO18: To find the nth derivatives of functions

CO19: Apply the Leibnitz's theorem for finding nth derivative of product of two functions

CO20: Apply Taylor's and Maclaurin's series for finding series expansions of functions and approximating values

CO21: Understand the concept of indeterminate forms, their occurrence in problems and their evaluation

CO22: Formulate equations from available data and find solutions to real life problems

CO23: Acquire the knowledge of the relationship between coefficients and roots of an equation

CO24: Explain different methods for finding the roots of a given equation

CO25: Apply the theoretic knowledge of different methods for finding the roots of a given equation into practical problems

CO26: Acquire the knowledge of different techniques of transforming equations to convenient forms

CO27: Explain different methods like Descartes Method, Cardan's method, Ferrari's method in theory of equations

CO28: Develop skill in locating the position of roots and determining their character

CO29: Understand how to analyze and synthesize given data to solve problems in geometry

CO30: Understand the basic ideas of conics

CO31: Explain the ideas of conics and their various applications

CO32: Find the equation to tangent, normal at a point on a conic

CO33: Apply the properties of conics to solve problems in real life situations

CO34: Explain the ideas of conics to explain many natural phenomenon

CO35: Find the polar equation of a line, circle , tangent and normal to conics

CO36: acquire the basic knowledge of vector differentiation and vector integration

CO37: Determine and apply, the important quantities associated with scalar fields, such as partial derivatives of all orders, the gradient vector and directional derivative

CO38: Determine and apply, the important quantities associated with vector fields such as the divergence, curl, and scalar potential

CO39: Acquire the basic knowledge of Circular and Hyperbolic Functions of a Complex Variable

CO40: Familiarized with real and imaginary parts of a circular and hyperbolic functions of a complex variable

CO41: Distinguish between the various methods for separating complex numbers in various forms into real and imaginary parts

CO 42: Understand how to separate a complex function into its real and imaginary parts

CO43: Understand various types of numbers and their properties

CO44: Acquire the basic knowledge of Number Theory

CO45: Apply the knowledge of Number Theoretic Problems in practical situations

## Semester II

## CC3 &CC4: Real Analysis & Group Theory

Course Outcomes Upon completion of this course, students should be able to:

Course Outcomes Upon completion of this course, students should be able to:

CO1: Explain the basic idea of real numbers

CO2: Describe fundamental properties of the real numbers that lead to the formal development of real analysis

CO3: Describe the real line as a complete, ordered field

CO4: Determine the basic topological properties of subsets of the real numbers

CO5: Describe the terms limit and limit points of a set and explains closed and open sets

CO6: Differentiate between countable and uncountable sets and examples for them

CO7: Explain the idea about sequences and monotone property

CO8: Acquire the basic knowledge of convergence and divergence

CO9: Use the knowledge of convergence into problems

CO10: Demonstrate an understanding of limits and how they are used in sequences, series

CO11: Apply various theorems on the existence of limits of sequences and their evaluation

CO12: Use the definitions of convergence as they apply to sequences, series, and functions

CO13: Apply the knowledge of convergence to problems and the various theorems on convergence, absolute convergence and non-absolute convergence

CO14: Comprehend rigorous arguments developing the theory underpinning real analysis

CO15: Construct rigorous mathematical proofs of basic results in real analysis

CO16: Appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems

CO17: Produce rigorous proofs of results that arise in the context of real analysis

CO18: Demonstrate understanding of and the ability to verify relationships between operations satisfying various properties (e.g. commutative property)

CO19: Demonstrate understanding of and the ability to work within various algebraic structures

CO20: Assess properties implied by the definitions of groups and rings

CO21: Acquire the basic knowledge and the structure of Group, Subgroup and Cyclic Groups

CO22: Explain the significance of the notion of a normal subgroup, and of a simple group

CO23: Analyze and demonstrate examples of subgroups, normal subgroups and quotient groups

CO24: Use Lagrange’s Theorem to analyze the cyclic subgroups of a group

CO25: Acquire the notion of permutations and operations on them

CO26: Prove Cayley's theorem and understand its applications

CO27: Explain the terms isomorphism and homomorphism

CO28: Develop an idea about Isomorphism, homomorphism and automorphism

CO29: Understand homomorphism, inner automorphism and their properties

CO30: Understand Cayley's theorem and its applications

## Semester III

## CC V, CC VI,CC VII & SEC-I:

## Theory of Real Functions, Ring Theory, Linear Algebra, Ordinary Differential Equation & Multivariate Calculus, Programming with C

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: Describe the concepts and applications of derivatives and higher order derivatives

CO9: Understand the ideas of derivatives and higher order derivatives

CO10: Acquire the concept of finding partial derivatives and associated rules

CO11: Develop competency in applying the idea of partial derivatives

CO12: Expand functions using Taylor's and Maclaurin's series, Leibnitz theorem and use their applications

CO13: Acquire the concept of asymptotes and envelopes

CO14: Describe the characteristics of a ring, quotient rings and ideals

CO15: Understand Quotient Rings, Ideals and their existence with examples

CO16: Differentiate between Ring Ideals and Quotient Rings and also their properties

CO17: Familiarize with Rings, Integral Domains, Fields and Divisors of Zero

CO18: Familiarize with the concepts of Ideals and factor rings and homeomorphisms and factor rings

CO19: Acquire the knowledge of a matrix, basic operations, rank and determinant of a matrix

CO20: Understand the various applications of the theory of matrices to a wide variety of problems

CO21: Understand various methods for determining rank of a matrix

CO22: Acquire knowledge of invertible matrices and their properties

CO23: Recognize the concepts of the terms span, linear independence, basis, dimension, and apply these concepts to various vector spaces and subspaces

CO24: Introduce the new terms Basis and Dimension

CO25: Acquire the knowledge of ordered basis

CO26: Analyze vectors in Rn geometrically and algebraically

CO27: Analyze finite and infinite dimensional vector spaces and subspaces over a field and their properties, including the basis structure of vector spaces

CO28: Solve a System of Linear equations using the inverse of a matrix

CO29: Distinguish between consistent and inconsistent system of equations

CO30: Use matrix algebra and the relate matrices to linear transformations

CO31: Understand the concept of linear transformations and their properties

CO32: Use the definition and properties of linear transformations and matrices of linear transformations and change of basis, including kernel, range and isomorphism

CO33: Familiarize with transition matrices

CO34: Determine the Kernel of linear transformations and nullity of associated vector spaces

CO35: Compute with the characteristic polynomial and equation of a given square matrix

CO36: Familiarize characteristic roots and characteristic vectors

CO37: Determine eigen spaces, as well as the geometric and the algebraic multiplicities of an eigen value and apply the basic diagonalization result

CO38: Determine potency and index of nilpotency

CO39: Apply Cayley- Hamilton Theorem to problems for finding the inverse of a matrix and higher powers of matrices without using routine methods

CO40: Develop skill in finding the partial derivatives of functions of several variables and various rules associated

CO 41: Apply the chain rule for functions of several variables

CO 42: Use the Lagrange multiplier method to find extrema of functions with constraints

CO43: Apply the knowledge of Lagrange multipliers in finding the extreme values of functions

CO44: Make a comparative study of the extreme values of functions of a single independent variable with functions of several independent variables

CO45: Identify, analyze and subsequently solve physical situations whose behavior can be described by ordinary differential equations

CO46: Understand the order, degree and various standard forms of differential equations

CO47: Determine solutions to first order separable differential equations

CO48: Determine solutions to first order linear differential equations

CO49: Explain an integrating factor, which may reduce the given differential equation into an exact one and eventually provide its solutions

CO50: Familiarize the orthogonal trajectory of the system of curves on a given surface

CO51: Determine solutions to first order exact differential equations

CO52: Determine solutions to second order linear homogeneous differential equations with constant coefficients

CO53: Understand the basic knowledge of complimentary function and particular integral

CO54: Determine solutions to second order linear non-homogeneous differential equations with constant coefficients

CO55: Evaluate and apply linear differential equations of second order (and higher)

CO56: Obtain power series solutions of differential equations

CO57: Develop the ability to apply differential equations to significant applied and/or theoretical problems

CO58: Investigate the qualitative behavior of solutions of systems of differential equations

CO59: Identify and obtain the solution of Clairaut's equation

CO 60: Understand and apply the programming concepts of C for solving mathematical problems

CO 61: Apply to find greatest common divisors, generate random numbers, and understand Cartesian geometry and algebraic concepts through programming.

CO 62: Represent the outputs of programs visually in terms of well formatted text and plots.

## Semester IV

## CC VIII, CC IX, CCX & SEC-II

## Riemann Integration, Series of Functions, Partial Differential Equation, Multivariate Calculus-II, Mechanics & Mathematical Logic

CO1: Understand partitions and their refinement

CO2: Understand Integrability and theorems on integrability

CO3: Acquire the idea about Riemann Integrability and Riemann Integration

CO4: Understand various theorems associated with Riemann Integration

CO5: Develop a knowledge about Riemann Integration and applies into problems

CO6: Determine the Riemann integrability of a bounded function and prove a selection of theorems concerning integration

CO7: Explain convergence of a series

CO8: Develop skill in checking the uniform convergence of series using various tests of convergence

CO9: Distinguish between Pointwise convergence and Uniform Convergence

CO10: Illustrate the convergence properties of power series

CO11: Illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability, and integrability

CO12: Determine the limit point of a series of functions

CO13: Understand convergence of different types improper integrals

CO 14: Understand the uses of improper integrals in various situations

CO15: Understand necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.

CO16: Determine the centre of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight.

CO19: Deal with the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.

CO 20: Learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.

CO 21: Calculate line integrals along piecewise smooth paths; interpret such quantities as work done by a force

CO22: Acquire the basic ideas of double and triple integral

CO23: Apply the techniques of double and triple integral to various problems of finding length of plane curves, surface areas and volumes of surfaces of revolution

CO24: Change variables in multiple integrals

CO25: Familiarized with different three dimensional surfaces and their properties

CO26: 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)

CO27: Be familiar with the modeling assumptions and derivations that lead to PDEs

CO28: Describe the origin of partial differential equation and distinguish the integrals of first order linear partial differential equation into complete, general and singular integrals

CO29: Familiarize with the various techniques of finding the solution of the differential equation $P/dx = Q/dy = R/dz$

CO30: Acquire the idea of Lagrange's method for solving the first order linear partial differential equations

CO31: Recognize the major classification of PDEs and the qualitative differences between the classes of equations

CO32: Be competent in solving linear PDEs using classical solution methods

## Semester V

## CC XI, CCXII, DSE- A(1) & DSE-B(1)

## Probability& Statistics, Group Theory-II & Linear Algebra-II, Advanced Algebra, Linear Programming & Game Theory

CO 1: Understand the basic concepts of probability.

CO 2: Appreciate the importance of probability distribution of random variables and to know the notion of central tendency.

CO 3: Establish the joint distribution of two random variables in terms their correlation and regression.

CO 4: Understand central limit theorem which shows that the empirical frequencies of so many natural populations exhibit normal distribution.

CO 5: Study entropy and information theory in the framework of probabilistic models.

CO 6: Understand distributions in the study of the joint behavior of two random variables.

CO 7: Establish a formulation helping to predict one variable in terms of the other that is,

Correlation and linear regression.

CO8: Understand central limit theorem, which establish the remarkable fact that the empirical frequencies of so many natural populations, exhibit a bell shaped curve.

CO 9: Understand the basic concepts of group actions and their applications.

CO 10: Recognize and use the Sylow theorems to characterize certain finite groups

CO 11: Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields.

CO 12: Learn in detail about polynomial rings, fundamental properties of finite field extensions, and classification of finite fields.

CO13: Define a LPP in standard form and Canonical form

CO14: Identify a feasible solution, a basic feasible solution and an optimal solution using simplex method

CO15: Understand the new term LPP

CO16: 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

CO17: Place a Primal linear programming problem into standard form and use the Simplex Method or The Big M Method to solve it

CO18: 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

CO19: Use dual simplex method to find optimal solutions

CO20: Understand duality theorems and dual simplex method

CO21: Identify the advantages of duality method

CO22: Apply the theorems on duality to problems appropriately

CO23: Use dual simplex method to find optimal solutions

CO24: Find the dual, and identify and interpret the solution of the Dual Problem from the final tableau of the Primal problem

CO25: Explain the concept of complementary slackness and its role in solving primal / dual problem pairs

CO 26: 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

CO27: Acquire the knowledge of Transportation and Assignment problems

CO28: Understand various methods of solving Transportation and Assignment Problems

CO29: Explain the Transportation Problem and formulate it as an LPP and hence solve the problem CO18: Determine that an Assignment Problem is a special case of LPP and hence solve by Hungarian method

CO30: Become familiar with various terms and rules used in the Theory of Games

CO31: Identify the various methods and theories of games

## Semester VI

## CC XIII, CCXIV, DSE-A (2), DSE-B (2)

## Metric Space & Complex Analysis, Numerical Methods & Numerical Methods Lab, Fluid Statics & Elementary Fluid Dynamics, Point Set Topology

**Course Outcomes Upon completion of this course, students should be able to:**

CO1: Understand the basic concepts of open sets, closed sets, Cantor sets and metric spaces

CO2: Understand the various properties of metric spaces

CO3: Become familiar with convergence in metric spaces and theorems on convergence

CO4: Explore various properties of complete metric spaces and relate them with convergence of sequences

CO5: Understand and applies the knowledge of metric spaces various contexts

CO6: Compute sums, products, quotients, conjugate, modulus, and argument of complex numbers

CO7: Write complex numbers in polar form

CO8: Introduce elementary complex functions

CO9: Find all integral roots and all logarithms of nonzero complex numbers

CO10: Evaluate exponentials and integral powers of complex numbers

CO11: Define and analyze limits and continuity for complex functions as well as consequences of continuity

CO12: Determine whether a given function is differentiable, and if so find its derivative

CO13: Use differentiation rules to compute derivatives

CO14: Understand the significance of differentiability for complex functions and be familiar with the Cauchy-Riemann equations

CO15: Conceive the concepts of analytic functions and will be familiar with the elementary complex functions and their properties

CO16: 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

CO17: Use antiderivatives to compute line integrals

CO18: Understand the basic methods of complex integration and its application in contour integration

CO19: Understand the theory and techniques of complex integration

CO20: Find parameterizations of curves, and compute complex line integrals directly

CO 21: Evaluate integrals along a path in the complex plane and understand the statement of Cauchy's Theorem

CO 22: Use Cauchy’s integral theorem and formula to compute line integrals

CO23: Evaluate complex contour integrals directly and by the fundamental theorem and applying the Cauchy integral formula

CO24: Express complex-differentiable functions as power series

CO25: Analyze sequences and series of analytic functions and types of convergence

CO26: Identify the isolated singularities of a function and determine whether they are removable, poles, or essential

CO27: Compute Laurent series at an isolated singularity, and determine the residue

CO28: Apply the theory into application of the power series expansion of analytic functions C

CO29: Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem

CO 30: Obtain numerical solutions of algebraic and transcendental equations

CO 31: Find numerical solutions of system of linear equations and check the accuracy of the solutions. CO 27: Learn about various interpolating and extrapolating methods

CO 32: Solve initial and boundary value problems in differential equations using numerical method

CO 30: Apply various numerical methods in real life problems.

CO 32: Understand the reduction of force system in three dimensions to a resultant force acting at a base point and a resultant couple. I

CO 33: Learn about a nul point, a nul line, and a nul plane with respect to a system of forces acting on a rigid body together with the idea of central axis.

CO 34: Know the inertia constants for a rigid body and the equation of momental ellipsoid together with the idea of principal axes and principal moments of inertia to derive Euler's dynamical equations.

CO 35: Study the kinematics and kinetics of fluid motions to understand the equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates which are used to derive Euler's equations and Bernoulli's equation.

CO 36: Deal with two-dimensional fluid motion using the complex potential and also to understand the concepts of sources, sinks, doublets and the image systems of these with regard to a line and a circle.

CO 37: define the notion of topology, construct various topologies on a general set which is not empty by using different kinds of techniques, compare these topologies and identify the special subsets of the topology that are called base and subbase which generate elements of the topology.

CO 38: define the notion of topology.

CO 39: construct various topologies on a general set, compare them if it is possible.

CO 40: explain the notion of base and subbase and identify that a subset of a topology is a base or a subbase for this topology.

CO 41: construct topologies which accept a given family of sets base or subbase.

CO 42: use the set of functions which are defined on a same set, constructs the weak topology on the domain of these functions.

CO 43:constructthe subspace topology which is defined on subsets ofthe topological space by using the topology of a given topological space, construct the product topology on the cartesian product of topological spaces by using given two or more topological spaces and construct the quotient topology on a family of sets which is decomposed by an equivalence relation.

CO 44: define the subspace topology.

CO 45: construct the product topology on product spaces.

CO 46: construct the quotient topology.

CO 47: define and categorize the separation axioms which separate a point from another point, a point from a set that does not contain this point and a set from another set.

CO 48: express $T_1$, $T_2$, $T_3$ and $T_4$ separation axioms and use them to prove various properties.

CO 49: solve hydrostatic problems.

CO 50: describe the physical properties of a fluid.

CO 51: calculate the pressure distribution for incompressible fluids.

CO 52: calculate the hydrostatic pressure and force on plane and curved surfaces.

CO 53: demonstrate the application point of hydrostatic forces on plane and curved surfaces.

CO 54: formulate the problems on buoyancy and solve them.

CO 55: describe the motion of fluids.

CO 56: describe the principles of motion for fluids.

CO 57: describe the areas of velocity and acceleration.

CO 58: formulate the motion of fluid element.

CO59: identify derivation of basic equations of fluid mechanics and apply

CO 60: identify how to derive basic equations and know the related assumptions.

CO 61: apply the equation of the conservation of mass.

CO 62: apply the equation of the conservation of momentum

CO 63: apply the equation of the conservation of energy

CO 64: Understand different types of error in numerical computation, its derivation and elimination

CO 65: Know the use of different difference operators and their relations.

CO 66; Understand the use of different interpolation problem and different numerical differtian and integration formula

CO 67: Know the use of different numerical formulae to solve algebraic and transcendental equation

CO 68: Apply Numerical analysis which has enormous application in the field of Science and some fields of Engineering.

CO 69: Familiar with finite precision computation.

CO 70: Familiar with numerical solutions of nonlinear equations in a single variable.

CO 71: Familiar with numerical integration and differentiation, numerical solution of ordinary differential equations.

CO 72 Familiar with calculation and interpretation of errors in numerical method. 6. Familiar with programming with numerical packages like C+, C++, FORTRAN 99.

Annexure-II

**PO, PSO, CO of UG program in Mathematics as Minor Subject**

## Program Specific Outcomes

**On the completion of B.Sc. course with Mathematics as minor subject, students will be able to:**

P S O 1:- Solve complex problems by critical understanding analysis and synthesis.

P S O 2:- Demonstrate & understand the common body of knowledge in mathematics and demonstrate the ability to apply analytical & theoretical skill to model & to solve the mathematical problem.

P S O 3:- Use basic definition in linear & Abstract Algebra & Real Analysis and to simple consequence of this definition.

P S O 4:- Critically interpret data, write reports and apply the basic rules of evidence.

P S O 5:- Provide a systematic understanding of the concepts and theories of mathematics and its application in the real word – to an advance level and enhance carrier prospects in a huge array of field.

## Program Outcomes

**By the end of a B. Sc. program with Mathematics as minor subject, 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

# Course Outcome

## Semester-I

### Algebra-I, Differential Calculus-I, Differential Equation-I & Coordinate Geometry

**On the completion of Semester-I of UG course with Mathematics as minor subject, students will be able to:**

C O 1:- Understand the concepts of hyperbolic and inverse hyperbolic function, de-movers theorem and its application.

C O 2:- Study and understand definition of the limit of function, basic properties of limits, continuous functions and classification of discontinuities.

C O 3:- Study second orders linear differential equations with constant coefficients, Homogeneous linear ordinary differential equations reducible to homogeneous differential equations.

CO4: Differentiate between various types of functions

CO5: To introduce the concept of a dependent variable depending on more than two dependent variables and finding partial derivatives

CO6: To find the nth derivatives of functions

CO7: Apply the Leibnitz's theorem for finding nth derivative of product of two functions

CO8: Formulate equations from available data and find solutions to real life problems

CO9: Acquire the knowledge of the relationship between coefficients and roots of an equation

CO10: Explain different methods for finding the roots of a given equation

CO11: Apply the theoretic knowledge of different methods for finding the roots of a given equation into practical problems

CO12: Acquire the knowledge of different techniques of transforming equations to convenient forms

CO13: Explain different methods like Descartes Method, Cardan's method, Ferrari's method in theory of equations

CO14: Develop skill in locating the position of roots and determining their character

CO15: Understand how to analyze and synthesize given data to solve problems in geometry

CO16: Understand the basic ideas of conics

CO17: Explain the ideas of conics and their various applications

CO18: Find the equation to tangent, normal at a point on a conic

CO19: Apply the properties of conics to solve problems in real life situations

**Semester-II**

**Differential Calculus-II,**
**Differential Equation-II,**
**Vector Algebra &Discrete Mathematics**

**On the completion of Semester-II of UG course with Mathematics as minor subject, students will be able to:**

CO1: Apply Taylor's and Maclaurin's series for finding series expansions of functions and approximating values

CO2: Understand the concept of indeterminate forms, their occurrence in problems and their evaluation.

CO3: Explain the idea about sequences and monotone property

CO4: Acquire the basic knowledge of convergence and divergence

CO5: Use the knowledge of convergence into problems

CO6: Demonstrate an understanding of limits and how they are used in sequences, series

CO7: Apply various theorems on the existence of limits of sequences and their evaluation

CO8: Use the definitions of convergence as they apply to sequences, series, and functions

CO9: Apply the knowledge of convergence to problems and the various theorems on convergence, absolute convergence and non-absolute convergence

CO10: Understand various types of numbers and their properties

CO11: Acquire the basic knowledge of Number Theory

CO12: Apply the knowledge of Number Theoretic Problems in practical situations

CO13: Develop the ability to apply differential equations to significant applied and/or theoretical problems

CO14: Investigate the qualitative behavior of solutions of systems of differential equations

CO 15: Develop the ability to solve 1st order partial differential equation using Lagrange's method and Charpit's Method

CO16: Develop the ability to apply partial differential equations to significant applied and/or theoretical problems.

CO17: acquire the basic knowledge of vectors, linear dependence, independence, scalar product and vector product of vectors and it application in geometry and mechanics.

**Semester –III**

**Integral Calculus, Numerical Methods**
**&Linear Programming, C programing language**

**On the completion of Semester-III of UG course with Mathematics as minor subject, students will be able to:**

CO 1: Understand the concept of definite integral and limit of a sum as definite integral

CO 2: Know the recurrence relation in integration sum functions

CO3: Understand convergence of different types improper integrals

CO 4: Understand the uses of improper integrals, beta and gamma functions in various situations

CO 5: Know the concept and use of double integral

CO 6: Know use of definite integral in finding length, area and volume

CO 7: Understand different types of error in numerical computation, its derivation and elimination

CO 8: Know the use of different difference operators and their relations.

CO 9; Understand the use of different interpolation problem and different numerical differtian and integration formula

CO 10: Know the use of different numerical formulae to solve algebraic and transcendental equation

CO11: Understand the new term LPP

CO12: Define a LPP in standard form and Canonical form

CO13: Identify a feasible solution, a basic feasible solution and an optimal solution using simplex method

CO14: Formulate and model a linear programming problem from a word problem and solve them graphically in 2 dimension.

CO15: Use dual simplex method to find optimal solutions

CO16: Understand duality theorems

CO17: Place a Primal linear programming problem into standard form and use the Simplex Method or The Big M Method to solve it

CO 18: Acquire the knowledge of Transportation and Assignment problems

CO19: Understand various methods of solving Transportation and Assignment Problems

CO 20: Understand and apply the programming concepts of C for solving mathematical problems

CO 21: Apply to find greatest common divisors, generate random numbers, and understand Cartesian geometry and algebraic concepts through programming.

CO 22: Represent the outputs of programs visually in terms of well formatted text and plots.

## Semester –IV

## Algebra-II, Computer Science & Programming, Probability & Statistics

**On the completion of Semester-IV of UG course with Mathematics as minor subject, students will be able to:**

CO1: Demonstrate understanding of and the ability to work within various algebraic structures

CO2: Assess properties implied by the definitions of groups and rings

CO3: Acquire the basic knowledge and the structure of Group, Subgroup

CO4: Describe the characteristics of a ring and subring, integral domain, field and subfield

CO5: Compute with the characteristic polynomial and equation of a given square matrix and know the use of Caley Hamilton's theorem

CO6: Familiarize eigen values and eigen vectors of a square matrix

CO7: Determine eigen spaces, as well as the geometric and the algebraic multiplicities of an eigen value and apply the basic diagonalization result

CO 8: Know the history of computer.

CO 9: Understand the difference between high level and machine language

CO 10: Have the idea and use of positional number system, bit, and byte.

CO 11: Know how to write algorithm and flowchart for solving different real life problems

CO 12: Know how to write FORTRAN 77/99 programme for solving simple mathematical problem

CO 13: Understand the basic concepts of probability.

CO14: Appreciate the importance of probability distribution of random variables and to knowthe notion of central tendency.

CO 15: Establish the joint distribution of two random variables in terms their correlation andregression.

CO 16: Understand central limit theorem which shows that the empirical frequencies of so manynatural populations exhibit normal distribution.

CO 17: Study entropy and information theory in the framework of probabilistic models. CO 18: Understand

distributions in the study of the joint behavior of two random variablesCO 19: Establish a formulation helping to

predict one variable in terms of the other that is,

Correlation and linear regression.

CO 20: Understand central limit theorem, which establish the remarkable fact that the empiricalfrequencies of so many natural populations, exhibit a bell shaped curve.

## Semester V/VI Particle Dynamics

**On the completion of Semester-V/VI of UG course with Mathematics as minor subject,students will be able to:**

CO1: Understand and use basic terms for the description of the motion of particles, vectorfunctions and the fundamental laws of Newtonian mechanics

CO 2: Solve mechanics problems in one dimension that involve one or more of the forces ofgravity, friction and air resistance

CO 3: Understand the concept of terminal speed, and use it in solving mechanics problems inone dimension

CO 4: Apply Newton's second law in vector form to problems in more than one dimensionCO 5: Solve problems relating to the motion of a projectile in the absence of air resistance. CO 6: Apply Kepler's law of motion in solving planetary motion

CO 7: understand motion under inverse square law