24MA111 Calculus & Real Analysis

Course Category: Basic Sciences (BS) **3L 1T 0P 4C**
Pre – requisite: 10 + 2 Mathematics

Course Description:

Calculus is a fundamental branch of mathematics that deals with the study of change. It provides a framework for understanding how quantities change over time or space and has two main branches: differential calculus and integral calculus. Real analysis is a branch of mathematics that deals with the rigorous study of the real numbers and the functions defined on them. It provides a theoretical framework for understanding the properties of real-valued sequences and functions, continuity, limits, differentiation, integration, and infinite series.

Course Aims and Objectives:

1. Familiarize differentiation rules and theorems to solve problems related to rates of change and optimization.
2. Explain various methods for solving first order first degree differential equations and the study of solutions that satisfy the equations and the properties of the solutions.
3. Teach concepts of second and higher order differential equations and to develop analytical methods (like characteristic equations and method of undetermined coefficients) to find solutions for these equations.
4. Discuss the sequence whether it is convergent or divergent by using the appropriate tests.
5. Explain methods to analyze the convergence and divergence of infinite series and to expand functions using ratio tests.

Course Outcomes:

At the end of the course, the student will be able to

CO-1: Classify the problems involving Maxima and Minima. [K2]

CO-2: Explain analytical skills to solve both linear and nonlinear differential equations,and understanding the conditions for existence and uniqueness of solutions.[K3]

CO-3: Analyze and solve the problems of first and higher order d ifferential equations.[K4]

CO-4: Understand properties of limits of sequences, including the Squeeze theorem and the Limit Laws, and understand their applications in analyzing sequences.[K2]

CO-5: Apply tests for convergence and divergence, such as the comparison test, ratio test and integral test.[K3]

Course Structure:

UNIT-I: FUNCTIONS OF FINITE VARIABLES **(12Hours)**

Limits, Continuity, Partial differentiation, partial derivatives of first and second order, Jacobian, Taylor's theorem of two variables (without proof). Maxima and Minima of two variables, Lagrange's method of undetermined Multipliers.

UNIT – II: FIRST ORDER, FIRST DEGREE ODE AND ITS APPLICATIONS: (12Hours)

Differential equations of first order and first degree - Exact differential equation , Linear and Bernoulli differential equation , Applications of differential equations of first order and first degree - Newton's law of cooling, Law of natural growth and decay, Orthogonal trajectories.

UNIT – III: SECOND AND HIGHER ORDER ODE WITH CONSTANT COEFFICIENTS **(12Hours)**

Second order linear differential equations with constant coefficients. Solution of Homogeneous differential equations, Non homogeneous terms of the type e^{ax}, sin(ax), cos(ax), polynomials in x^k, $ea^x.V(x)$, $x.V(x)$.

UNIT – IV: SEQUENCES (12Hours)

Sequences, Range of sequences, Sub sequences, Bounded sequences, Limit of a sequences, convergent sequences, Divergent and oscillatory sequences, sandwich Theorem and related problems, monotonic sequences – theorems – related problems, Bolzano Weistrass theorem – related problems, Cauchy sequences, Cauchy general principle of convergence – Related problems, Cauchy's first theorem of limits, Corollary of Cauchy's first theorem on limits, related problems, Cauchy's second theorem on limits and related problems.

UNIT – V: INFINITE SERIES **(12Hours)**

Introduction to Infinite Series, behaviour of the series, Cauchy's general principle of convergence for series, series of non-negative terms, Geometric series, Auxiliary series, Comparison test of first type, second type, Limit Comparison test – Related Problems, Cauchy's nth root test – Related problems, D'Alembert's ratio test and their problems, Alternating series, Leibnitz's test and Problems, Absolute convergent series, conditionally convergent series.

Text Books:

1. Bhattacharya P.B, Jain S.K & Nagpaul S.R. (2016). *Basic Abstract Algebra* (2nd Edition). Cambridge University Press.
2. Venkateswara Rao V, Krishna Murthy N, Sarma B.V.S.S & Anjaneya Sastry S. (2019). *A Text Book of B.Sc Mathematics (Differential Equations) – Vol I.* S. Chand & Company Pvt. Ltd.
3. Venkateswara Rao V, Krishna Murthy N, Sarma B.V.S.S & Anjaneya Sastry S. (2019).

A Text Book of B.Sc Mathematics – Real Analysis – Course 4. S. Chand & Company Pvt. Ltd.

Reference Books:

1. Jain R. K. & Iyengar S. R. K (2016). *Advanced Engineering Mathematics* (5th Edition). Narosa Publishing House.
2. Ramana B.V (2018). *Higher Engineering Mathematics* (33rd reprint). McGraw Hill Education (India) Private Limited.