Mathematical Physics - I

Assam University
FYUG · Semester 1 · Credits 3
PHYDSC101T

OBJECTIVES

- To introduce mathematical tools required for solving problems of interest to physicists
- To enable students to model physical problems mathematically and solve them using appropriate techniques
- To expose students to fundamental mathematical methods applicable to a wide range of physics problems

COURSE CONTENT

Unit 1: Vector Algebra and Matrices (9 Hours)

Scalar and vector products, Physical interpretation of vector product, Scalar and vector triple products and their properties, Derivation of important vector identities, Preliminary ideas of scalar and vector fields, Different types of matrices, Symmetric and antisymmetric matrices, Hermitian matrix and its properties, Inverse and transpose of matrices, Solution of simultaneous linear equations, Eigenvalues and eigenvectors, Diagonalization of a matrix

Unit 2: Ordinary Differential Equations (9 Hours)

Order and degree of a differential equation, General form of first order differential equations, Separation of variables, Exact differential equations, Inexact differential equations and integrating factors, Linear differential equations, Second order differential equations, Homogeneous differential equations with constant coefficients, Wronskian and general solution, Complementary function, Methods for finding particular integrals

Unit 3: Vector Calculus (10 Hours)

Directional derivative and normal derivative, Gradient of a scalar field and its geometrical interpretation, Divergence of a vector field, Curl of a vector field, Laplacian operator, Vector identities, Ordinary integrals of vectors, Line integrals of vector fields, Surface integrals of vector fields, Volume integrals of vector fields, Gauss's divergence theorem, Stokes' theorem

Unit 4: Orthogonal Curvilinear Coordinates (8 Hours)

Definition of orthogonal curvilinear coordinates, Examples of orthogonal curvilinear coordinate systems, Transformation between curvilinear and Cartesian coordinate systems, Expressions for infinitesimal line, surface and volume elements, Gradient in curvilinear coordinate systems, Divergence in curvilinear coordinate systems, Curl in curvilinear coordinate systems, Laplacian in curvilinear coordinate systems, Spherical coordinate system, Cylindrical coordinate system

Unit 5: Beta and Gamma Functions and Numerical Techniques (9 Hours)

Beta and Gamma functions, Relation between Beta and Gamma functions, Expression of integrals in terms of Gamma functions, Solution of algebraic and transcendental equations by bisection method, Solution of equations by Newton-Raphson method, Numerical integration using Simpson's rule, Interpolation using Newton-Gregory forward difference formula, Interpolation using Newton-Gregory backward difference formula

LEARNING OUTCOMES

- Understand the concepts of vector algebra and vector calculus
- Perform line, surface and volume integrations and apply relevant theorems
- Apply concepts of curvilinear coordinates to physical problems
- Understand special functions such as Beta and Gamma functions

- Apply basic numerical techniques to solve algebraic and transcendental equations

REFERENCES

- Mathematical Physics – H. K. Dass
- Mathematical Physics with Classical Mechanics – S. Prakash
- Mathematical Methods for Physicists – G. B. Arfken, H. J. Weber, F. E. Harris
- Differential Equations – George F. Simmons
- Vector Analysis – Murray R. Spiegel