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