Mathematical Physics

Level: B. Sc. Credit: 3
Year: III Semester: I
PHYS 302

Objective:- The main objective of this course is to apply the advance mathematical tools for resolving problems related to physics. Delivery of the topics of the syllabus will be illustrated by relevant physical problems. On completion of this course, the students will be capable to formulate and analyze many physical problems using appropriate mathematical tools.

Linear Vector Space and Curvilinear Coordinates: (6 hrs.)
Definition of linear vector space: Problems; Linear independence and basic vectors: The scalar product, problems.
Generalized curvilinear coordinates; Orthogonal curvilinear coordinates; Gradient, divergence, curl and Laplacian in orthogonal curvilinear, plane polar, cylindrical and spherical polar coordinates: Problems.

Tensor Analysis: (7 hrs.)
Contravarient, covariant and mixed tensors; Kronecker delta; Rank of tensor; Scalrs or invariants; Tensor fields; Symmetric and skew-symmetric tensors; Fundamental operations with tensors; Line element and metric tensor; Length of a vector; Christoffel's symbols; Transformation laws of Christoffel's symbols; Geodesics; Covariant derivatives; Tensor form of gradient, divergence, curl and Laplacian.

Fourier Series and Integral Transform: (7 hrs)
Definition of Fourier series; Dirichlet's condition; Fourier series in exponential form; Uses of Fourier series (discontinuous function and periodic function); Application of Fourier series (square wave, triangular wave, full and half wave rectifier, etc.); Fourier and Laplace transforms; Inverse Fourier and Laplace transforms; Fourier transform of derivatives; Application of Fourier and Laplace transforms.

Operators, Eigen vectors and Eigen values: (5 hrs)
Linear operators: Domain, codomain and range; Matrix representation of linear operators; Adjoint operator and Hermitian operators; Eigenvalue equations: Problems.

Green Functions: (7 hrs)
General properties: An example from electrodynamics; The eigenstate method; The continuity method; Time dependent wave equation: solution for the Green function by Fourier transformation; Wave equation.

Complex Variable: (8 hrs)
Introduction; Functions of complex variables; Analytic functions and Cauchy-Reimann condition; Cauchy-integral theorem and formula; Taylor and Laurent series; Singularities; Poles; Residues theorem and applications.

Special Differential Equations: (8 hrs.)
Special differential equations (Bessel, Legendre, Hermite and Laguerre) and their series solutions, recurrence relations, polynomials, Rodrigue's formula, orthogonality of polynomials: Problems.

Text books:

1. *Mathematical Methods for Physicist* – G. B. Arfkin and H. J. Weber. Elsevier.
2. *Mathematical Methods for Physics and Engineering* – K. F. Riley, M. P. Hobson and S. J. Bence. Cambridge University Press
3. *Mathematical Methods in the Physical Sciences* – M. L. Boas. Willey India.

References:

1. *Vector Analysis* – M. R. Spiegel, S. Lipschutz and D. Spellman. Tata Mcgraw Hill Education Pvt. Ltd.
2. *Complex Variable and Applications* – R.V. Chulchil, J. W. Brown, and R. F. Verkey. Tata Mcgraw Hill Educations Pvt. Ltd.
3. *Introduction to Mthematical Physics* – C. Harper. PHI Learning Pvt. Ltd.
4. *Mathematical Physics* – S. L. Kakani and C. Hemrajani. CBS Publishers and Distributors.
5. *Mathematical Physics* – H. K. Dass. S. Chand and Company Ltd.
6. *Mathematical Physics* – B. D. Gupta. Vikas Publishing House Pvt. Ltd.
7. *Mathematical Physics* – B. S. Rajput. Pragati Prakashan Ltd.
8. *Mathematical Physics for Engineers and Scientist* – A. K. Mukhopadhyaya. IK International Publishing House Pvt. Ltd.