SYLLABI OF PHYSICS DSC PAPERS

SEMESTER-I

PHYDSC101T

MATHEMATICAL PHYSICS-I

Contact Hours: 45

Full Marks = 100 [ESE (70) CCA (30)]

Course objective: *The emphasis of the course is on various tools required for solving problems of interest to physicists. The course will teach the students to model a physics problem mathematically and then solve those numerically using computational methods. The course aims to expose the students to some fundamental mathematical tools enabling them to solve a wide range of physics problems.*

Unit 1: Vector Algebra and Matrices

Scalar and vector products, Physical interpretation of vector product. Scalar and vector triple products & their properties with physical interpretation. Derivation of important 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. Eigenvalue, Eigenvectors and diagonalization of a matrix. **(9 Lectures)**

Unit 2: Ordinary differential equations

Order and Degrees of a differential equation. First Order ODE: General form of first order ODE- $Mdx + Ndy = 0$, Separation of variables, Exact equation, in-exact equations and integrating factors, Linear equations. Second Order ODE: Homogeneous Equations with constant coefficients. Wronskian and general solution. Complementary function. Methods for finding particular integrals. **(9 Lectures)**

Unit 3: Vector Calculus

Vector Differentiation: Directional derivatives and normal derivatives. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Laplacian operator. Vector identities.

Vector Integration: Ordinary Integrals of Vectors. Line, surface and volume integrals of Vector fields. Gauss's divergence theorem and Stokes Theorem. **(10 Lectures)**

Unit 4: Orthogonal Curvilinear Coordinates

Definition and examples of Orthogonal Curvilinear Coordinates, transformation from orthogonal curvilinear coordinate systems to Cartesian coordinate system and vice versa. Expressions for infinitesimal line, surface and volume elements. Derivation of Gradient, Divergence, Curl and Laplacian in curvilinear Coordinate Systems (Spherical & Cylindrical). **(8 Lectures)**

Unit 5: Beta and Gamma Functions and Numerical Techniques

Beta and Gamma Functions: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.

Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson, Simpson Rule. Interpolation by Newton Gregory Forward & Backward difference formula. **(9 Lectures)**

Expected learning outcomes: *After completing this course, the students will be able to understand the concepts of vector algebras, vector calculus in addition to performing line, surface and volume integration and apply various theorems to compute these integrals. The students will also be able to understand concepts of curvilinear coordinates along with ideas of special functions and some numerical techniques.*

Reference Books:

i. Mathematical Physics by H.K. Dass, published by S. Chand.

ii. Mathematical Physics with Classical Mechanics by S. Prakash, published by Sultan Chand & Sons, Sixth edition.

iii. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn Elsevier.

iv. Differential Equations, George F. Simmons, 2007, McGraw Hill

v. Differential Calculus by B. C. Das and B. N. Mukherjee, published by U.N. Dhur

vi. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.

vii. Vector Analysis, by Murray R. Spiegel, published by McGraw Hill Education, part of the Schaum's Outlines Series.

viii. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press.

ix. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.

x. Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press.

xi. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.

xii. Mathematical Physics, Goswami, 1st edition, Cengage Learning.