MANGALORE UNIVERSITY

Department of Physics

MSc Physics

I Semester

PHH 401: METHODS OF MATHEMATICAL PHYSICS I

[52 Hrs.]

Course outcome

CO1 The student gains a compressive knowledge on vector analysisand curvilinear coordinates.

CO2Have knowledge of matrix representation of operators, Hilbert space and diagonalization of matrices.

CO3 Have understanding on complex variables.

C04Have clear idea of partial differential in equations and boundaryvalue problems in partial differential equations.

CO5 Have knowledge of special function and their applications in physics.

[13 hrs]

Unit I Vector analysis and curvilinear coordinates: Integration of vector functions - line integrals, surface integrals and volume integrals - vector theorems without proof (Gauss, Green's and Stokes') and their applications in physics.

Generalized coordinates - elements of curvilinear coordinates - transformation of coordinates - orthogonal curvilinear coordinates - unit vectors - expression for arc length, volume element. The gradient, divergence and curl in orthogonal curvilinear coordinates. Laplacian in orthogonal curvilinear coordinates, spherical polar coordinates, cylindrical coordinates.

[13 hrs]

Unit II Matrices and complex variables: Matrix representation of linear operators, Hermitian and unitary operators, Hilbert space. Diagonalisation of matrices – simultaneous diagonalisation.

Complex variables and integral transforms: Review of functions of a complex variable – Cauchy Riemann conditions. Contour integrals. Cauchy integral theorem, Cauchy integral formula. Taylor and Laurentz series. Zero isolated singular points, simple pole, m^{th} order pole. Evaluation of residues. The Cauchy's residue theorem. The Cauchy principle value. Evaluation of different forms of definite integrals. A digression on Jordan's lemma.

[13 hrs]

Unit III Partial differential equations: Review of system of surfaces and characteristics. First order partial differential equations for a function of two variables.

Linear second order partial differential equations. Classification into elliptic, parabolic and hyperbolic types.

Boundary value problems - solutions by method of separation of variables - solution of 1-, 2- and 3- dimensional wave equation and diffusion equation in Cartesian, plane, cylindrical and spherical polar coordinates.

[13 hrs]

Unit IV Special functions: Review of power series method for ordinary differential equations – description of beta and gamma functions.

Bessel functions – solution of Bessel's equation - generating function and recurrence relations – orthogonality of Bessel functions.

Legendre polynomials – solution of Legendre equation – generating function and recurrence relations – orthogonality property of Legendre polynomials.

Solution of Hermite equation – Hermite polynomials – generating functions and recurrence relations.

Text Books:

1. Arfken G, 'Mathematical Methods for Physicists' (Academic Press)
2. Harper C, 'Introduction to Mathematical Physics' (PHI, 1978)
3. Chattopadhyaya P K, 'Mathematical Physics' (Wiley Eastern, 1990)
4. Harry Lass, 'Vector and Tensor Analysis' (McGraw Hill, 1950)
5. Mary L Boas, 'Mathematical Methods in the Physical sciences' (John Wiley, 1983)
6. Joshi A W, 'Matrices and Tensors in Physics' (Wiley Eastern, 1995)
7. Ayres F, 'Differential Equations' (Schaum series, McGraw Hill)
8. Spiegel M R, 'Vector Analysis' (Schaum series, McGraw Hill, 1997)
9. Ayres F, 'Differential Equations' (Schaum series, McGraw Hill)
10. Sneddon I A, 'Elementary Partial Differential Equations' (McGraw Hill, 1957)

Reference Books:

1. Bose A K and Joshi M C, 'Methods of Mathematical Physics' (Tata McGraw Hill, 1984)
2. Sokolnikoff and Redheffer, 'Mathematics of Physics and Modern Engineering, (McGraw Hill, 1958)
3. Irving J and Mullneu N, 'Mathematics in Physics and Engineering' (Academic Press, 1959)
4. Kreysig E, 'Advanced Engineering Mathematics' (Wiley Eastern, 1969)
5. Mathews J and Walker R L, 'Mathematical Methods of Physics' (W A Benjamin, Inc, 1979)