BACHELORS WITH PHYSICS AS MAJOR
5th SEMESTER

PHY522J2 PHYSICS _ MATHEMATICAL PHYSICS-II

CREDITS: THEORY – 4, INTERNSHIP / TUTORIALS: 2

THEORY (4 CREDITS: 60 HOURS)

LEARNING OUTCOMES

The learning outcomes cover a broad range of topics in complex analysis, Fourier analysis, Laplace transforms, partial differential equations, and special functions. Students completing this course should have a strong understanding of these mathematical concepts and their applications.

1. *Understand the fundamentals of complex numbers and their representation in the complex plane.*
2. *Describe the Cauchy-Riemann conditions and their role in determining analytic functions.*
3. *Explain Cauchy's Integral Formula and its applications in calculating complex integrals.*
4. *Understand Taylor and Laurent expansion of complex functions and their applications.*
5. *Apply the calculus of residues and the Residue Theorem to evaluate complex integrals.*
6. *Understand the concept of Fourier series and Fourier transform.*
7. *Calculate the Fourier transforms of derivatives and understand their implications.*
8. *Introduce the Laplace transform and its properties.*
9. *Define partial differential equations and boundary conditions in the context of partial differential equations.*
10. *Solve first-order partial differential equations and apply separation of variables.*
11. *Explain the concept of singular points in second-order differential equations and solve them using the Frobenius method.*
12. *Define Bessel functions of the first kind and their orthogonality properties.*
13. *Introduce Neumann functions and Henkel functions and their relevance.*
14. *Understand Legendre functions, their orthogonality, and their applications in spherical harmonics.*
15. *Describe associated Legendre functions and their significance in quantum mechanics.*
16. *Introduce Hermite functions and Laguerre functions and their applications in solving differential equations.*

UNIT-I (15 HOURS)

Complex functions, Analytic functions, Cauchy - Riemann conditions, Cauchy's Integral Theorem, Singularities, Cauchy's Integral formula, Derivatives, Taylor and Laurent expansion, Analytic continuation, Poles and Branch Points, Calculus of Residues, Residue theorem, Cauchy principal value.

UNIT-II (15 HOURS)

Fourier Series, Properties and Applications. Fourier transform, Sine, Cosine and Complex transforms with examples, Definition, Properties and Representations of Dirac Delta Function, Properties of Fourier Transforms, Transforms of derivatives, Laplace transform, Properties and examples of Laplace Transform.

UNIT-III (15 HOURS)

Partial Differential Equations, Classes and Characteristics, Boundary Conditions, First-order, Separable variables, Solution of linear first-order ODEs; Separation of variables in cartesian, Spherical Polar and Cylindrical Coordinates. Singular points, Solution of Second order Differential Equations using Frobenius Method, Limitations of series approach.

UNIT IV (15 HOURS)

Bessel Functions of First kind, Orthogonality, Neuman Functions, Henkel Functions, Legendre Function, Orthogonality, Associated Legendre Function, Spherical Harmonics, Hermite Functions, Laguerre Functions.

INTERNSHIP OR TUTORIALS (2 CREDITS: 30 HOURS)

1. Evaluation of Definite Integrals using Cauchy's residues.
2. Fourier series Applications to Partial differential equations.
3. Laplace transform method of solving differential equations.
4. Self-Adjoint ODEs.
5. Modified Bessel Functions and their applications.
6. Applications of Spherical Bessel Function.

TEXT BOOKS:

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Willey.
2. Mathematical Physics by H.K. Dass, S. Chand
3. Mathematical Methods for Physicists, by Arfkeen, Weber and Harris, Elsevier.