SEMESTER I

M1PHY01-CT01: Mathematical Methods in Physics

External: 80 Marks | Internal: 20 marks

Lectures: 40hrs | Tutorials : 10 hrs

Additional Contact Hours : 10 (seminars, quiz, assignments, group discussion etc.)

UNIT – I

Coordinate Systems: (4hrs)

Curvilinear coordinates, differential vector operations, special coordinate systems- rectangular Cartesian, spherical polar and circular cylindrical coordinates, and expressions of gradient, divergence, curl and Laplacian

Tensors: (4hrs)

Coordinate transformations, scalars, contravariant and covariant vectors, definition of contravarient, mixed and covariant tensor of second rank, Addition, subtraction and contraction of tensors, quotient rule

UNIT –II

Matrices: (4hrs)

Orthogonal matrices, Orthognality conditions- two and three dimensional cases, Hermitian and unitary matrices, Pauli matrices, Dirac matrices, Diagonalization of matrices- Eigen value and Eigen vectors

Elementary Group Theory: (4hrs)

Definition of group, Isomorphism and Homomorphism, Matrix representation- reducible and irreducible groups, subgroup-invariant subgroup, Discrete groups-two objects two-fold symmetry axis, three objects-three-fold symmetry axis, Continuous Groups- orthogonal group O_3^+, special unitary group SU(2)

UNIT – III

Second Order Differential Equations: (4hrs)

Separation of variables-ordinary differential equations, singular points, series solutions – Frobenius method and its limitations, Wronskian-linear independence and linear dependence

Special Functions: (4hrs)

Bessel functions of the first kind, integral representation, Legendre functions-generating function, recurrence relations and orthogonality, Associative Legendre functions, spherical harmonics, Hermite functions. Laguerre functions.

UNIT –IV

Complex Variables: (8hrs)

Functions of complex variable, Cauchy- Rieman conditions, Cauchy Integral theorem, Cauchy integral formula, Laurent expansion, Calculus of residues –poles, Essential singularities and branch points, Residue theorem, Jordan's lemma, Singularities on contours of integration, Evaluation of definite integrals.

UNIT –V

Fourier Series and Fourier Transforms: (4hrs)

Fourier series- General properties and uses, Differentiation and integration of Fourier series, Fourier transforms, Fourier integral-exponential form, Fourier transform-inversion theorem

Laplace Transform: (4hrs)

Elementary Laplace transforms, Laplace transform of derivatives, substitution properties of Laplace transform

Tutorials: (10hrs)

Applications of topics covered in each unit in Physics (based on problems given in the reference books) as given in the detailed lecture schedule will be covered in the tutorial classes.

Recommended Books:

Mathematical methods for Physicists – George B. Arfken & Hans J. Weber

Applied Mathematics for Physicists and Engineers – L. A. Pipes