PH 701 MATHEMATICAL PHYSICS AN NUMERICAL METHODS 3 0 0 6

Mathematical Physics

Linear Algebra: Vector spaces and its properties, inner product spaces, linear transformation, similarity transformations, orthonormal sets, eigenvalues and eigenvectors. Complex Analysis: Cauchy-Riemann conditions, contour integrals, Residue theorem and applications. Partial differential equations and special functions (Legendre, Hermite and Lauguerre polynomials, Bessel functions, Neumann functions, etc.), Separation of variables in cartesian, spherical and cylindrical coordinates, properties of special functions.

Numerical Methods

Error analysis. Roots of nonlinear equations: Newton-Raphson method, solution of linear equations: Gauss-Jordan elimination, matrix inversion and LU decomposition, Eigenvalues and Eigenvectors. Interpolation and curve fitting: Least square fitting, linear and nonlinear, application in physics problems. Numerical differentiation and integration: Numerical differentiation formulae, Simpson's rule and Gauss-Legendre integration. Solution of ODE and PDE: Runge-Kutta and finite difference methods.

Texts:

1. G. B. Arfken and H. J. Weber, *Mathematical Methods for Physicists*, Academic Press (1995)
2. K. E. Atkinson, *Numerical Analysis*, John Wiley, Low Price Edition (2004).

References:

1. J. Mathews and R.L. Walker, *Mathematical Methods of Physics*, Pearson Education (2004)
2. S. C. Chapra and R. P. Canale, *Numerical Methods for Engineers*, Tata McGraw Hill (2002).
3. E. Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, Low Price Edition (2001).

PH 702 CLASSICAL MECHANICS AND ELECTRODYNAMICS 3 0 0 6

Classical Mechanics:

Review of Newtonian mechanics. Lagrange's equation and its applications, variational principle, principle of least action. Central force: Equation of motion, classification of orbits, Virial theorem, Kepler problem. Rigid body motion: Euler angles, angular momentum and kinetic energy, inertia tensor, Euler equations and applications. Small oscillations: Eigenvalue problem, normal modes, forced vibrations, dissipation. Hamilton's equations, Canonical transformations, Poisson brackets, Hamilton-Jacobi theory, action-angle variables.

Electrodynamics

Solution of Laplace's and Poisson's equations, multipole expansion and Green's function approach to electrostatic and magnetostatic problems. Maxwell's equations and electromagnetic waves, wave propagation in dielectric and conducting media. Lienard-Wiechert potential, accelerated charges, Bremsstrahlung, electric dipole fields and radiation. Relativistic Electrodynamics: Covariant formalism of Maxwell's equations, transformation laws.

Texts

1. H. Goldstein, *Classical Mechanics*, Narosa (1985).
2. J. D. Jackson,*Classical Electrodynamics*, John Wiley (1999).

References:

1. N. C. Rana and P. S. Joag, *Classical Mechanics*, Tata McGraw Hill (1994).
2. L. D. Landau and E. Lifshitz, *Mechanics*, Butterworth (1995).

3. L. D. Landau and E. M. Lifshitz, *Electrodynamics of Continuous Media*, Butterworth (1995).
4. G. S. Smith, *Classical Electromagnetic Radiation*, Cambridge (1997).

PH 703 QUANTUM MECHANICS AND STATISTICAL MECHANICS 3 0 0 6

Quantum Mechanics

Operator formalism, Schrodinger equation, applications such as particle in a box, harmonic oscillator, hydrogen atom. Angular momentum, L-S coupling, J-J coupling, Clebsch-Gordon coefficients, Pauli matrices, commutation relations. Perturbation theory: Stark effect, He atom, α-decay, anomalous Zeeman effect. Relativistic quantum mechanics: Klein-Gordon and Dirac equations.

Statistical Mechanics

Microcanonical, Canonical and Grand Canonical ensembles. Partition function and it's applications. Ideal quantum gas. Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, applications such as Doppler broadening, Einstein coefficients, specific heat of solid, black body radiation, electrons in metal, white dwarf stars, etc. Transport phenomena: Diffusion, random walk, Einstein's relations, Boltzmann transport equation, electrical properties.

Texts

1. E. Merzbacher, *Quantum Mechanics*, John Wiley, Low Price Edition (1999).
2. R. K. Pathria, Statistical Mechanics, Butterworth-Heinemann (1996).

References:

1. J. J. Sakurai, *Quantum Mechanics*, Pearson Education (2002).
2. J.J. Sakurai, *Advanced Quantum Mechanics*, Pearson Education (2002).
3. S. R. A. Salinas, *Introduction to Statistical Physics*, Springer (2004).
4. K. Huang, *Statistical Mechanics*, John Wiley, Low Price Edition (2000).

PH 704 EXPERMENTAL TECHNIQUES AND SCIENTIFIC PRESENTATION 3 0 0 6

Experimental Techniques

Low pressure: Rotary, sorption, oil diffusion, turbo molecular, getter and cryo pumps. McLeod, thermoelectric, Penning, hot cathode ionisation and Bayard Alpert gauges. Partial pressure measurement, leak detection, gas flow through pipes and apertures, effective pumping speed, vacuum components, thermal evaporation, e-beam, sputtering and laser ablation systems. Low temperature: Gas liquifiers, cryogenic fluid baths, cryostat design, closed cycle He refrigerator (CCR), low temperature thermometry. Sources, sensors and instruments: Principle and characteristics of LASERs. Classification and principle of various sensors. Signal averaging and lock-in detection. Principle and applications of powder X-ray diffractometer, spectrophotometer; Fourier transform-Infrared (FT-IR) spectrometer, fluorimeter, atomic force microscope, electron microscope, Energy dispersive X-ray analysis (EDAX) and optical spectrum analyzer.

Scientific Presentation

Art of scientific writing (steps to better writing, flow method, organization of material and style), development of communication skills, presentation of scientific seminars.

Texts

1. A. D. Helfrick and W.D.Cooper, *Modern Electronic Instrumentation and Measurement Techniques*, PHI (1996).

2. G. K. White, *Experimental Techniques in Low Temperature Physics*, Clarendon (1993).
3. A. Roth, *Vacuum Technology*, Elsevier (1990).
4. H. J. Tichy, *Effective Writing for Engineers, Managers, Scientists*, John Wiley & Sons (1988).

References:

1. A. Ghatak and K.Thyagarajan, *Optical Electronics*, C.U.P. (1991).
2. D. A. Skoog, F. J. Holler and T. A. Nieman, *Principles of Instrumental Analysis*, Saunders College Publishers (1998).