MANGALORE UNIVERSITY
MSc Medical Physics

MPH 401: Fundamentals of Physics

Teaching hours: Each Unit – 12 h

To familiarise the students with the basics of fundamental physics required to understand the basic processes, interactions, and interconnectedness of nuclear radiations with both physical and life science disciplines.

Course Outcomes:

- Students will be familiar with the fundamental principles of physics required to understand the multidisciplinary nature of medical physics programme.
- They will learn basic thermodynamic laws, basics of optical principles and lasers useful to the programme.
- Students will learn basics of condensed matter physics, thermodynamics, and electrodynamics required to understand the processes and interactions of nuclear radiations with other areas of science.
- They will get familiar with basics of classical and quantum statistics required understand and appreciate the random nature of the radioactivity and its interactions.
- Students will also learn basic quantum mechanics to understand the nuclear radiations behaviour and their interactions.

Unit I: Condensed Matter Physics

States of matter, crystalline and amorphous materials, thin films and nano structures.Luminescence in solids. Free electron theory and band theory: Free electron theory of metals. Density of states. Fermi energy above 0 K. Electronic specific heat. Pauli paramagnetism.Electrical conductivity of metals.Conductors, semiconductors and superconductors.

Absorption processes - Photoconductivity – Photoelectric effect – Photovoltaic effect – Photoluminescene – Thermoluminescence – Flouresecnce – Radioluminesce- Phosphorescence - Colour centres – Types of colour centres – F-Centre - Generation of colour centres.

Unit II: Thermodynamics, Optics and Lasers

Thermodynamic system.Laws of thermodynamics.Concept of entropy - principle of entropy increase - entropy and disorder.

Properties oflight, electromagnetic spectrum.Reflection, refraction, total internal reflection of light. Optical fiber and its structure functioning.

LASER, characteristics of laser, diode laser, high power laser, laser applications.

Unit III: Classical and Quantum Statistics

Classical statistics: Boltzmann distribution, calculation of velocities - average and r.m.sveleocities. Gibbs‘ paradox, Sackur - Tetrode equation, partition functions - translational partition funciotn, vibrational, rotational and electronic partition functions.Boltzmannequipartition theorems.

Quantum statistics: Bosons and Fermions - Bose-Einstein and Fermi-Dirac distributions – degenerate Fermi and Bose gases - Bose-Einstein condensation - Planck‘s law of black-body radiation.

Unit IV: Electrodynamics

Maxwell's equations in vacuum, Maxwell's equations inside matter.Uniqueness theorems, separation of variables for Poisson's equation.Relaxation to a stationary state, Propagating plane electromagnetic (EM) wave, decaying plane EM wave. Energy in static electric field, Energy in static magnetic field, Energy stored and transported by EM waves. EM waves at dielectric boundaries: reflection, refraction, EM waves in conductors: inside and at the boundary. Rectangular waveguides, Circular cylindrical waveguides, Coaxial cable, Cavities. Wave equation for scalar and vector potentials with sources, solving the wave equation with sources. Electric and magnetic fields: radiation components, Radiation energy loss, Radiation from antennas. Multipole expansion, Electric dipole radiation, Magnetic dipole and electric quadrupole radiation.

Unit V: Quantum Mechanics

General formulation of quantum mechanics: Schrödinger wave equation - review of concepts of wave particle duality, matter waves, wave packet and uncertainty principle. Schrödinger‘s equation for free particle in one and three dimensions - equation subject to forces.Probability interpretation of the wave function, probability current density - normalisation of the wave function, box normalisation, expectation values and Ehrenfest‘s theorem.

Textbook:

1. Powell and Crassman, _Quantum Mechanics‘(Addison Wesley, 1961)
2. Mathews P M and Venkatesan K, _A Text Book of Quantum Mechanics‘ (Tata McGraw Hill, 1977)
3. Ghatak A K and Lokanathan S, _Quantum Mechanics‘, III Edn. (McMillan India, 1985)
4. Sakurai J J, _Modern Quantum Mechanics‘, Revised Edn. (Addison Wesley, 1994)
5. David J. Griffiths, *Introduction to Electrodynamics*, fourth edition [QC680.G74 2013]
6. Mark A. Heald and Jerry B. Marion, *Classical Electromagnetic Radiation* [QC661.H43 1995]
7. William C. Elmore and Mark A. Heald, *Physics of Waves* [531.33El64P]
8. Davison E. Soper, *Classical Field Theory* [QC174.45.S65 2008]

Reference Books:

1. Cohen Tannoudji C, Diu B and Laloe, ‗Quantum Mechanics', Vol. I (John Wiley, 1977)
2. Schiff L I, ‗Quantum Mechanics', III Edn. (McGraw Hill, 1968)
3. Shankar R, ‗Principles of Quantum Mechanics' (Plenum, 1980)
4. French A P and Taylor E F, `An introduction to Quantum Physics' (W W Norton, 1978)
5. Gasirowicz, ‗Quantum Physics' (Wiley, 1974)
6. Wichmann E H, ‗Quantum Physics' (McGraw Hill, 1971)
7. V Devanathan, ‗Quantum Mechanics', Narosa Publishers
8. Arul Das, ‗Quantum Mechanics', New Age Publishers
9. Aggarval, ‗QuantumMechanics', 10.