

Semester 5 Minor
Course- 354T
(Minor Course – 4 Credits)

Semester: 5	Course No.: 354(T)	Course Code: PHE 354(T) Course Title -Nuclear Physics-Electronics-Wave optics- Quantum mechanics
Credits: 4	1 Session = 1 hour	Course Category: Minor Paper

Course Objectives:

By the end of this course, students should be able to:

1. Understand fundamental concepts of nuclear physics, including radioactive decay, nuclear reactions, and structure of atomic nuclei.
2. Analyze the working principles, characteristics, and applications of transistors and other solid state electronic devices.
3. Comprehend the principles of wave optics, including diffraction and resolving power of optical instruments.
4. Apply classical mechanics to central force problems and particle collisions, and understand the implications in orbital motion and scattering phenomena.

Course Outcomes: On successful completion of the course the learner will be able to

CO	COURSE OUTCOMES	Bloom's Verb
CO-1	Remember the concept of radioactive decay, half life and mean life of radioactive element. Understand the decay and growth of radioactive element. Also understand different equilibrium. Evaluate the estimated value of age of the earth by using lead method and carbon dating method.	Remember Understand Apply
CO-2	Remember the construction and basic working of transistor and zener diode. Understand the different configuration of transistor and their characteristics. . Evaluate different parameters like collector cut off current, leakage current etc. Also understand regulation process executed by zener diode working of tunnel diode. Also calculate different parameters related to regulation process which helps to design any regulator circuit.	Remember Understand Evaluate Application
CO-3	Basic wave concept of light is studied using the diffraction phenomenon. Apply the knowledge to understand the resolutions of some basic optical instruments	Understand Apply
CO-4	Develop a conceptual understanding of the Time-dependent and Time-independent Schrodinger equations, their physical significance, and their application to basic quantum systems such as free particles, particles in a box, and barrier potential. Analyze and interpret the general wave equation, the physical meaning of the wave function, and probability current density. Students will discuss non-normalizable wave functions and the significance of box normalization. Solve the Schrodinger equation for standard potentials (infinite square well, particle in a box, and barrier potential), understand quantization of energy levels, and explain the concept of stationary states and their time evolution. Understand and articulate the general formalism of wave mechanics including the use of operator algebra, fundamental postulates, adjointness and self-adjointness of operators, eigenvalue problems (including degeneracy, observables, and normalization), and the use of Dirac delta functions and closure relations in quantum mechanic. Describe and employ critical tools such as the probability interpretation for [N]-particle systems, the completeness of eigenfunctions, and normalization conditions necessary for quantum descriptions	Understand Apply Analyse

Unit No.	Unit Contents	Sessions Allotted
1	<p>Nuclear Physics</p> <p>Radioactivity The law of radioactive decay (review), Radioactive growth and decay, ideal equilibrium, Transient equilibrium and secular equilibrium, Radioactive series, Radioactive isotopes of lighter elements, Artificial radioactivity, Age of earth, Carbon dating (Archaeological time scale)</p> <p>The Q Equation Types of Nuclear Reactions, The balance of mass and Energy in Nuclear reactions, The Q Equation, Solution of the Q Equation.</p> <p>Constituents of the nucleus properties Measurement of Nuclear radius, Constituents of the nucleus and their properties.</p>	15 Hours
2	<p>Electronics</p> <p>Basic characteristics of the Transistor: Basic Transistor amplifier, Two diode analogy for a transistor, Transistor input characteristics, Transistor collector characteristics, collector cut off current I_{CEO}, Forward current transfer ratio CE, Permissible operating area of a transistor CE, The basic common base amplifier, CB, Forward current transfer ratio CB, relation between α and β, collector cut off current I_{CBO}, physical explanation of CB and CE amplifying action, reduction of CE leakage current to I_{CO}, common collector amplifier, identifying the transistor leads</p> <p>Solid state electronics Devices: zener diode, zener diode specification, the voltage regulator circuit, design of a voltage regulator circuit, effect of supply voltage variation, zener break down mechanism, the tunnel diode, application of tunnel diode, the silicon controlled rectifier, the Uni junction transistor.</p>	15 Hours
3	<p>Wave Optics :Diffraction of Light</p> <p>Fresnel class Fresnel's half period zones, zone plate, difference between interference & diffraction, Fresnel & Fraunhofer diffraction.</p> <p>Fraunhofer class Fraunhofer diffraction at two slits, diffraction at N slits, Plane diffraction grating, Dispersive power of grating, Grating at oblique incidence.</p> <p>Resolving power of optical Instrument Resolving power, Rayleigh's criterion of resolution, resolving power of telescope, relation between magnifying power & the resolving power of telescope, Resolving power of a plane diffraction grating, difference between resolving power & dispersive power of grating, comparison of prism & grating spectra.</p>	15 Hours
4	<p>Quantum mechanics:</p> <p>A. Time – dependent Schrodinger Equation, Free Particle Wave Equation, General Wave Equation, Physical Interpretation of Wave Function, Probability Current Density, Non Normalizable Wave Function and Box Normalization, Time Independent Schrodinger Equation, Particle in an Infinite Square Well, Particle in a Box, The Barrier Potential.</p> <p>B. General Formalism of wave mechanics: The Schrodinger Equation and the probability interpretation for an N – particle system, the fundamental postulates of wave mechanics, The adjoint of an operator, and self adjointness. The eigen value problem, Degeneracy, eigen values and Eigen functions of self – adjoint operators, the Dirac delta function, Observables: Completeness and normalization of Eigen functions, closure.</p>	15 Hours

Unit 1: Text Book: Nuclear Physics – An introduction, S. B. Patel, New Age International Limited.

Chapter -2: Articles nos.: 2.3, 2.6 to 2.13 chapter-3: Article nos.: 3.2 to 3.5 Chapter-4: Article nos.:4.1.3, 4.1.4.

Reference Books:

Nuclear Physics, Irving Kaplan; Addison- Wesley Publishing company

Nuclear Physics, S. N. Ghoshal; S. Chand Publications.

Unit 2: Text Book: Electronics Devices and Circuits, Allen Mottershed, PHI

Chapter-9:Articles: 9.1 to 9.15, 9.18 Chapter-11: Article nos.:11.1 to 11.6, 11.9 chapter-6: Article nos.: 6.1 to 6.6, 6.11, 6.12 chapter-28: Article nos.: 28.1, 28.5

Reference Books:

Electronic Principles (7th Edition), Albert Malvino & David J. Bates, TMcGHill Pub.

Electronic Devices and Circuits by Sanjeev Gupta, Dhanpatrai & Sons.

Unit 3: Text Book: Optics & atomic physics by Singh, Agrawal (Pragati Prakashan, Meerat)

Chapter-7:Articles: 7.3 to 7.6 Chapter-8: Article nos.: 8.6 to 8.8, 8.15, 8.16 chapter-9: Article nos.: 9.1 to 9.4, 9.8 to 9.10

Reference Book:

Optics, Ajay Ghatak, Tata McGraw Hill Ltd.

A Textbook of Optics, N. Subrahmanyam & Brij Lal (S. Chand & Company Ltd.)

Unit: 4 Quantum mechanics:

Text books:

1) Modern Physics by G. Aruldas, P. Rajagopal, PHI Learning Private

Limited, 2021. Chapter 4: Article no: 4.8, 4.9, 4.10, 4.11 Chapter-6: Article nos.: 6.2, 6.3, 6.4.

2) A Textbook of Quantum mechanics by PM Mathews and K. Venkatesan, Tata Mc

Grew Hill. Chapter-2: Article no: 2.5 Chapter-3: Article nos.: 3.1 to 3.8

Reference books:

1) Quantum Mechanics by John L. Powell, Bernd Crasemann, Narosa Publishing House, 1994.

2) Quantum Mechanics by G. Aruldas, PHI Limited -2009

3) Quantum Mechanics by H. C. Verma, Surya Publications

4) Quantum Mechanics- A text book for Undergraduates by Mahesh C. Jain, PHI Ltd.