TITLE : MODERN PHYSICS I CODE : AP301

CREDIT VALUE : 3 LEVEL : III

PRE-REQUISITE : Nil

KEYWORDS : Particle properties of waves, wave properties of particles, atomic structure and spectra, wave mechanics, free electron gas, band theory of solids, electron and hole dynamics in semiconductor.

AIM

The aims of this subject are to introduce some of the main concepts of modern physics and its applications to some important physical systems including solids and semiconductors.

LEARNING OUTCOMES

Category A Professional/academic knowledge and skills

On completing the subject, students will be able to

SA1 articulate the experimental basis for attributing particle properties to waves and wave properties to particles; elaborate on the de Broglie theory of matter waves; apply Heisenberg's uncertainty principle to simple systems; apply the probabilistic interpretation of wave function to simple problems;

SA2 describe the scientific ideas behind the historical atomic models and recognize and justify the various modifications of classical ideas as new experimental evidences emerged; use Bohr's semiclassical model to interpret energy levels and spectra and recognize the limitations of the model;

SA3 elaborate on the various forms of Schrödinger's equation and identify the meaning of each term in the equation(s); solve Schrödinger's equation for the problem of particle in a box;

SA4 explain the formation of energy bands in solids;

SA5 use a nearly-free electron model to explain the origin of Ohm's law;

SA6 use the Fermi-Dirac distribution to find the Fermi energy levels in intrinsic and extrinsic semiconductors;

SA7 explain the concept of effective masses of electrons and holes in a semiconductor; and

SA8 solve problems involving the equilibrium concentrations of electrons and holes in a semiconductor.

Category B Attributes for all-roundness

On completing the subject, students are expected to be better trained/educated/prepared in the acquisition of the following skills/attributes:

SB1 be able to analyze, evaluate, synthesize and propose solutions to problems of a general nature; and

SB2 possess a desire for life-long learning and self-learning.

SYLLABUS

Particle properties of waves: photoelectric effect, wave-particle duality.

Wave properties of particles: de Broglie hypothesis, uncertainty principle.

Atomic structure and spectra: Bohr's theory of hydrogen atom, correspondence principle, atomic excitation.

Wave mechanics: the wave equation, Schrödinger equation, expectation values, stationary states, particle in a box.

Free electron gas: Fermi-Dirac distribution, Ohm's law.

Band theory of solids: formation of bands in solids, Fermi energy.

Electron and hole dynamics in semiconductor: effective mass, intrinsic and extrinsic semiconductors, electron and hole concentrations at equilibrium, mobility and conductivity, pn junction.

MODE OF STUDY

Lecture	35 hours
Tutorial	7 hours
Total	42 hours

ASSESSMENT WEIGHTING

Coursework (35%)		Examination (65%)		Total
Written Test 1 Written Test 2 Assignment Written Quiz	10% 10% 10% 5%	Written Examination	65%	100%

To pass the subject, students must obtain grade D or above in the examination.

LIST OF TEXTBOOK

Jewett/Serway	Physics for Scientists and Engineers with Modern Physics Volume 2, 7th Edition	Cengage Learning 2008
Beiser, A	Concepts of Modern Physics, 6th Edition	McGraw Hill 2003

LIST OF READING

Ohanian, H C	Modern Physics, 2nd Edition	Prentice Hall 1995