END SEMESTER EXAMINATION :
APRIL – MAY, 2015

APPLIED PHYSICS – II

Time : 3 Hrs. Maximum Marks : 70

Note: Attempt questions from all sections as directed.

SECTION – A (30 Marks)

Attempt any five questions out of six.
Each question carries 06 marks.

1. (a) Derive the time independent Schrödinger equation for free particle. (4)

(b) An Eigen function of the operator \( \frac{d}{dx} \) is \( \psi = e^{3x} \).
Find the corresponding eigen value. (2)

2. A particle of rest mass \( m_0 \) has a kinetic energy \( K \).
Show that its de Broglie wavelength is given by
\[
\lambda = \frac{hc}{\sqrt{K(K + 2m_0c^2)}}.
\]

P.T.O.
3. The distance between (110) planes in a body centered cubic structure is 0.203 nm. What is the size of the unit cell? What is the radius of the atom?

4. The critical magnetic field and critical temperature of lead are $6.5 \times 10^4$ A/m and 7.18 K, respectively. Calculate critical current density for 1 mm diameter wire of lead at 4.2 K.

5. Determine the magnetization and flux density in silicon, if its magnetic susceptibility is $-4.2 \times 10^{-6}$ and the magnetic field is $1.19 \times 10^5$ A/m. What would be the value of the relative permeability of the material?

6. (a) State and prove Gauss’s law in dielectrics. (4)

   (b) Derive the following relation between electric field strength vector $E$, electric displacement $D$ and electric polarization vector $P$:

   $$ D = \varepsilon_0 E + P $$  \hfill (2)

**SECTION - B** (20 Marks)

**Attempt any two questions out of three.**

Each question carries 10 marks.

7. (a) Deduce the expressions for carrier concentration of free electrons and holes in an intrinsic semiconductor. (6)
(b) The Bragg's angle in the first order for (220) reflection from nickel (FCC) is 38.2°, when X-rays of wavelength 1.54 Å are employed in a diffraction experiment. Determine the lattice parameter of nickel.

8. (a) Find the expectation values of the position \( <x> \) and of momentum \( <p_x> \) of a particle trapped in a one dimensional rigid box of length \( L \).

(b) Discuss the differences between polar and non-polar molecules with examples.

9. (a) Describe the V-I characteristics of p-n junction diode. What do you understand by drift and diffusion current in the case of a semiconductor?

(b) Explain type-I and type-II superconductors.

SECTION C (20 Marks)

(Compulsory)

10. (a) Write Schrödinger equation for a particle in a box and determine expression for energy Eigen value and Eigen function. Does this predict that the particle can possess zero energy?
(b) A potential difference of 100 volts is applied across a parallel plate capacitor of plate separation 1 cm and then a dielectric slab of dielectric constant 7 is inserted between the plates. Calculate the value of (i) The polarization \( P \) in the dielectric, (ii) The displacement \( D \) in the dielectric (iii). The Electric field intensity in the presence of dielectric. (5)

(c) (i) Calculate the interplaner spacing for a (321) plane in a simple cubic lattice whose lattice constant is \( 4.2 \times 10^{-9} \) m. (2½)

(ii) Sketch the following planes in a cubic unit cell: (101), (121), and (010). (2½)