B.E. 2nd Semester Examination, May–2012

PHYSICS–II

Paper–PHY–102-E

Time allowed : 3 hours]   *[Maximum marks : 100*

*Note : Attempt **five** questions, selecting at least two questions from each part.*

Part–I

1.   (a)   State and prove the Bragg's law for X-ray diffraction. Describe Bragg's X-ray spectrometer and explain how it is used to analyze the crystal structure ?   10

      (b)   What do you mean by inter-planar distance ? Show that in a cubic lattice of parameter 'a', the distance between successive planes of indices (hkl) is given by

$$d_{hkl} = a/(h^2 + k^2 + l^2)^{1/2}$$ 10

2.   (a)   State Planck and de Broglie quantum hypotheses and explain the concept of wave particle dualism.   10

(b) What are stationary states ? Starting from time dependent Schrodinger equation derive time independent Schrodinger equation.   10

3. (a) Outline the main assumptions of quantum theory of free electrons. Show that the energy of electrons in a metal is quantized (i.e. become discrete).   10

(b) What is Fermi energy level ? Introducing the concept of density of states and Fermi distribution function, compute Fermi energy of free electron gas at $T = 0$ K.   10

4. (a) Discuss the main features of ionic and covalent bonding.   6

(b) What is a wave packet ? Show that the group velocity associated with a wave packet is equal to the particle velocity. Find the relation between phase velocity and group velocity and hence show that for a non-relativistic particle phase velocity is half the group velocity (i.e. $V_p = (1/2) V_g$).   14

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Part–II

5. (a) What is Hall effect and what is its significance ? Derive an expression for Hall's coefficient and explain how does it distinguish between N and P type of semiconducting materials ? 10

   (b) Starting from the condition

   $$P \, \sin(\alpha a)/(\alpha a) + \cos(\alpha a) = \cos(ka)$$

   (Where the symbols have their usual meanings), explain how does the motion of electrons in periodic potentials (Kronig-Penney model) leads to the formation of energy bands. Discuss the effect of P on energy band spectrum. 10

6. (a) What are Solar cells ? Describe, in detail, the construction and working of solar cell. Draw the V-I characteristics and determine the Fill factor of solar cell. 10

   (b) What is E-K diagram ? Explain the concept of Brillouine zones and draw Brillouine zones in one and two dimensions. 10

7. (a) What is magnetization ? Compute the magnetic moment associated with an electron circling about the nucleus.   8

   (b) What is spontaneous magnetization ? Discuss the domain structure of ferromagnetic substances. Give an account of Weiss theory to explain essential features of ferromagnetic substances.   12

8. (a) What is superconductivity ? Discuss the effect of magnetic field on superconductivity. State Meissner effect.   10

   (b) Derive London's equations for superconductors.

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