

Model Question

Course Title: Physics (PHY113)

Semester: I

Duration: 3 Hours

Full Marks: 60

Pass Marks: 24

Credit Hour: 3

Attempt any TWO questions.

[10 x 2 = 20]

1. What do you mean by the equilibrium current across the pn junction? Use Fermi-Dirac statistics and Maxwell-Boltzmann distribution to show the flow of electrons from n to p is equal to the flow from p to n . How electron current from p to n (that is, associated with minority carriers) is not affected by the height of the potential energy barrier? Explain. [10]
2. Set up differential equation for an oscillation of a spring using Hooke's and Newton's second law. Find the general solution of this equation and hence the expressions for period, velocity and acceleration of oscillation. [10]
3. Set up Schrodinger equation for Hydrogen atom using spherical polar coordinates and separate radial and angular part of this equation. Without solving radial and angular equations, discuss the quantum numbers associated with these. [10]

Attempt any EIGHT questions.

[5 x 8 = 40]

1. Explain Hall effect and discuss the importance of Hall voltage while manufacturing electronic devices. [5]
2. What do you mean by Bloch theorem? Discuss its use in Kronig-Penny model and hence in band theory. [5]
3. Describe the following process of IC production: (a) Oxidation, (b) Pattern definition, and (c) Doping. [5]
4. A given spring stretches 0.1 m when a force of 20 N pulls on it. A 2-kg block attached to it on a frictionless surface is pulled to the right 0.2 m and released. (a) What is the frequency of oscillation of the block? (b) What is its velocity at the midpoint? (c) What is its acceleration at either end? (d) What are the velocity and acceleration when $x = 0.12$ m, on the block's first passing this point? [5]
5. Two large parallel plates are separated by a distance of 5 cm. The plates have equal but opposite charges that create an electric field in the region between the plates. An α particle ($q = 3.2 \times 10^{-19}$ C, $m = 6.68 \times 10^{-27}$ kg) is released from the positively charged plate, and it strikes the negatively charged plate 2×10^{-6} sec later. Assuming that the electric field between the plates is uniform and perpendicular to the plates, what is the strength of the electric field? [5]
6. What are (a) the energy, (b) the momentum, and (c) the wavelength of the photon that is emitted when a hydrogen atom undergoes a transition from the state $n = 3$ to $n = 1$? [5]
7. For a free quantum particle show that the wavefunction, $\psi(x, t) = A \cos kx e^{-i\omega t}$ satisfies the time dependent Schrodinger equation. [5]
8. Copper has a face-centered cubic structure with a one-atom basis. The density of copper is 8.96 g/cm³ and its atomic weight is 63.5 g/mole. What is the length of the unit cube of the structure? [5]
9. The output of a digital circuit (y) is given by this expression:
$$y = (\bar{A}B + \bar{C}A)(\bar{B} + \bar{C})$$
Where A, B and C represent inputs. Draw a circuit of above equation using OR, AND and NOT gate and hence find its truth table. [5]