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14PHY12/22

**First/Second Semester B.E. Degree Examination, June/July 2015**

**Engineering Physics**

Time: 3 hrs.

Max. Marks: 100

**Note: 1. Answer FIVE questions, selecting ONE full question from each part.**

**2. Physical constants : Velocity of light,  $c = 3 \times 10^8$  m/s; Planck's constant,  $h = 6.63 \times 10^{-34}$  Js; Mass of electron,  $m = 9.1 \times 10^{-31}$  kg; Charge of electron,  $e = 1.6 \times 10^{-19}$  C; Boltzmann's constant,  $k = 1.38 \times 10^{-23}$  J/K.**

**PART - A**

- 1 a. Write the assumptions of quantum theory of radiation and deduce Rayleigh-Jeans law from Planck's law. (05 Marks)
- b. Give four important properties of matter waves. (04 Marks)
- c. Set up time independent Schrodinger wave equation in one dimension. (07 Marks)
- d. Calculate the energy in eV, for the first excited state of an electron in an infinite potential well of width  $2 \text{ \AA}$ . (04 Marks)
- 2 a. State de Broglie hypothesis and show that the group velocity of the de Broglie waves of a particle is equal to the velocity of the particle. (05 Marks)
- b. State and explain Heisenberg's uncertainty principle. (05 Marks)
- c. Explain in brief the properties of wave function. If the wave function of a particle in an infinite potential box of width 'a' is  $\psi = B \sin(n\pi x/a)$  where x is the position and n is the quantum number, find B. (06 Marks)
- d. The wavelength of a fast neutron of mass  $1.675 \times 10^{-27}$  kg is 0.02nm. Calculate the group velocity and the phase velocity of its de Broglie waves. (04 Marks)

**PART - B**

- 3 a. Obtain an expression for the conductivity of a metal from quantum mechanical considerations. (06 Marks)
- b. Show that the Fermi level of an intrinsic semiconductor lies in the middle of the forbidden energy gap. (05 Marks)
- c. Explain the temperature dependence of resistivity of metal and state Matthiessen's rule. (05 Marks)
- d. Calculate the probability of an electron occupying an energy level 0.02 eV above the Fermi level at 300k. (04 Marks)
- 4 a. Define the terms drift velocity, mean free path, mean collision time and relaxation time. (04 Marks)
- b. Explain Hall effect. Arrive at the equation for Hall coefficient in terms of Hall voltage and current through the specimen. (08 Marks)
- c. Describe Maglev vehicle. (04 Marks)
- d. Calculate the concentration at which the acceptor atoms must be added to a germanium sample to get a p - type semiconductor with conductivity 0.15 per ohm-metre. Given the mobility of holes =  $0.17 \text{ m}^2/\text{Vs}$ . (04 Marks)



**PART – C**

- 5 a. Derive an expression for the radiant energy density under thermal equilibrium using Einstein's coefficients. (07 Marks)
- b. With suitable ray-diagrams, explain the principle construction of a holographic images. (05 Marks)
- c. Give an account of point to point communication system using optical fibers. (04 Marks)
- d. The angle of acceptance of an optical fiber kept in air is  $30^\circ$ . Find the angle of acceptance when the fiber is in a medium of refractive index  $4/3$ . (04 Marks)
- 6 a. Discuss the requisites and the conditions for a laser system. (06 Marks)
- b. Define angle of acceptance and numerical aperture. Obtain an expression for the numerical aperture of an optical fiber. (06 Marks)
- c. Explain measurement of pollutant in atmosphere using lasers. (04 Marks)
- d. A 5W pulsed laser emits light of wavelength 694 nm. If the duration of each pulse is 20ns, Calculate the number of photons emitted per pulse. (04 Marks)

**PART – D**

- 7 a. Mention the geometrical configurations of the seven crystal systems. (07 Marks)
- b. Sketch and describe the Perovskite structure. (05 Marks)
- c. Derive Bragg's equation. (04 Marks)
- d. The atomic radius of gold is 0.144nm. Determine the interplanar distance for (110) planes assuming that gold belongs to FCC system. (04 Marks)
- 8 a. With the help of vector diagram explain the terms basis vectors, lattice vector, interfacial angles and crystal parameters of a space lattice. (06 Marks)
- b. Derive an expression for interplanar distance in terms of Miller indices. (05 Marks)
- c. Define coordination number and packing factor. Compute the packing factor for BCC crystals. (05 Marks)
- d. In a calcite crystal, second order Bragg's reflections occur from the planes with d-spacing  $3\text{\AA}$ , at a glancing angle of  $24^\circ$ . Calculate the path difference between x-rays reflected from the two adjacent planes. Also, Calculate the wavelength of the x-rays. (04 Marks)

**PART – E**

- 9 a. Define shock waves. Mention its properties. (06 Marks)
- b. What are nanomaterials? Outline the structure of a carbon nano tube. (06 Marks)
- c. What is a scanning electron microscope? Mention its three applications. (04 Marks)
- d. The distance between the two pressure sensors in a shock tube is 100mm. The time taken by a shock wave to travel this distance is 200 microsecond. If the velocity of sound under the same conditions is 340 m/s, find the Mach number of the shock wave. (04 Marks)
- 10 a. Define Mach number, subsonic waves and supersonic waves. (03 Marks)
- b. Discuss the basics of conservation of mass, momentum and energy. (09 Marks)
- c. Explain the sol-gel method of preparing nanomaterials. (04 Marks)
- d. In a scanning electron microscope, electrons are accelerated by an anode potential difference of 60 kilo volt. Estimate the wavelength of the electrons in the scanning beam. (04 Marks)

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