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15PHY12

First Semester B.E. Degree Examination, Dec.2015/Jan.2016
Engineering Physics

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing one full question from each module.

2. Physical Constants: Velocity of light, $c = 3 \times 10^8$ ms^{-1}
Planck's constant, $h = 6.625 \times 10^{-34}$ JS
Mass of electron, $m = 9.1 \times 10^{-31}$ kg
Boltzmann constant, $K = 1.38 \times 10^{-23}$ JK^{-1}
Avogadro number, $N_A = 6.02 \times 10^{26}$/Kmol.

Module-1

1 a. Show that Planck's law reduces to Wein's law and Rayleigh-Jeans law at lower and higher wavelength limits respectively. **(06 Marks)**

b. Setup time independent Schrodinger wave equation in one dimension. **(06 Marks)**

c. A particle of mass 940 MeV/c^2 has kinetic energy 0.5 KeV. Find its de-Broglie wavelength, c is velocity of light. **(04 Marks)**

OR

2 a. Define phase velocity and group velocity. Obtain the relation between them. **(06 Marks)**

b. Using Heisenberg's uncertainty principle, prove that electrons cannot exist in a nucleus. **(06 Marks)**

c. The first excited state energy of an electron in an infinite well is 240 eV. What will be its ground state energy when the width of the potential well is doubled? **(04 Marks)**

Module-2

3 a. What is Fermi energy? Discuss the probability of occupation of various energy states by electron at T = 0K and T ≥ 0K on the basis of Fermi factor. **(06 Marks)**

b. What is Meissner's effect? Explain Type-I and Type-II super conductors. **(06 Marks)**

c. The effective mass for the electron in germanium is 0.55 m_0, where m_0 is the free electron mass. Find the electron concentration in Germanium at 300 K, assuming that the Fermi level lies exactly in the middle of the energy gap, given that the energy gap for Germanium is 0.66 eV. **(04 Marks)**

OR

4 a. Explain the success of quantum free electron theory. **(06 Marks)**

b. Explain the law of mass action and derive the expression for electrical conductivity of a semiconductor. **(06 Marks)**

c. Find the relaxation time of conduction electrons in a metal of resistivity 1.54×10^{-8} ohm-m, if the metal has 5.8×10^{28} conduction electrons per m^3. **(04 Marks)**

Module-3

5 a. Obtain an expression for energy density of radiation in terms of Einstein's coefficients. **(06 Marks)**

b. What is numerical aperture? Obtain an expression for numerical aperture in terms of refractive indices of core and cladding of an optical fiber. **(06 Marks)**

c. The ratio of population of two energy levels is 1.059×10^{-30}. Find the wavelength of light emitted at 330 K. **(04 Marks)**

OR

6 a. Explain construction and working of carbon dioxide laser device. **(06 Marks)**

b. With neat diagrams, explain different types of optical fibers. **(06 Marks)**

c. The attenuation of light in an optical-fiber is 2 dB/km. What fraction of its initial intensity remains after (i) 2 km, (ii) 5 km? **(04 Marks)**

Module-4

7 a. Define lattice points. Explain the crystal structure of diamond with neat sketch. **(06 Marks)**

b. Illustrate the procedure to find miller indices of a given plane and calculate the atomic packing factor for FCC. **(06 Marks)**

c. A beam of x-ray with wavelength 1.5 A; undergoes second order Bragg's reflection from the plane (211) of cubic crystal at glancing angle 54.38°. Calculate the lattice constant. **(04 Marks)**

OR

8 a. What is Bravais lattice? Obtain an expression for the interplanar spacing of planes in terms of Miller indices for cubic lattice. **(06 Marks)**

b. Describe the construction and working of a Bragg's x-ray spectrometer. **(06 Marks)**

c. Draw the following planes in a cubic unit cell:

i) (1 0 2) ii) (1 1 2) iii) (2 0 0) iv) $(1\ \bar{1}\ 0)$ **(04 Marks)**

Module-5

9 a. Describe the construction and working of Reddy's shock tube. **(06 Marks)**

b. What are nanomaterials? Write a note on sol-gel method of preparing nanomaterials. **(06 Marks)**

c. Define Mach number, subsonic waves, supersonic waves and Mach angle. **(04 Marks)**

OR

10 a. Describe the principle, construction and working of a scanning electron microscope. **(06 Marks)**

b. Explain the structures and applications of Carbon nanotubes. **(06 Marks)**

c. The distance between the two pressure sensors in a shock tube is 150 mm. The time taken by a shock wave to travel this distance is 0.3 ms. If the velocity of sound under the same condition is 340 ms^{-1}. Find the Mach number of the shock wave. **(04 Marks)**

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