

(2 Hours)

[Total Marks: 60]

N.B.: (1) Question No. 1 is compulsory.

(2) Attempt any three questions from Q.2 to Q.6.

(3) Assume suitable data wherever required.

(4) Figures to the right indicate marks.

Q1. Attempt any five

[15mks]

- Draw the following planes in a cubic unit cell (121), (100), (011).
- The diameter of 5<sup>th</sup> dark ring in Newton's ring experiment was found to be 0.42 cm. Determine the diameter of 10<sup>th</sup> dark ring in the same set up.
- An electron is bound in a one-dimensional potential well of width  $2 \text{ \AA}$  but of infinite height. Find its energy values in the ground state and in first excited state.
- Define superconductivity and explain the terms critical temperature and critical magnetic field.
- Find the resistivity of intrinsic germanium at 300 K. Given density of carriers is  $2.5 \times 10^{19} / \text{m}^3$ , mobility of electrons is  $0.39 \text{ m}^2/\text{volt-sec}$  and mobility of holes is  $0.19 \text{ m}^2/\text{volt-sec}$ .
- What are matter Waves? State three properties of matter waves.
- Explain the formation of colours in thin film.

Q2 a) State Hall Effect. Obtain an expression for Hall voltage. Calculate the mobility of charge carriers in a doped Si, whose conductivity is 100 per ohm meter and Hall coefficient is  $3.6 \times 10^{-4} \text{ m}^3/\text{C}$ . [8mks]

b) Obtain an expression for Optical Path Difference in a thin film of uniform thickness observed in reflected light. Hence obtain conditions for maxima and minima. [7mks]

Q3a) Explain with neat diagram the effect of doping and temperature on the fermi level in N type extrinsic semiconductor. What is the probability of an electron being thermally excited to the conduction band in Si at  $20^\circ \text{ C}$ . The band gap energy is  $1.12 \text{ eV}$  [8mks]

b) Show that the energy of an electron in a one-dimensional deep potential well of infinite height varies as the square of the natural numbers. [7mks]

Q4.a) Explain Bragg's spectrometer for the investigation of crystal structure with the help of a neat diagram. [5mks]

b) Derive one dimensional Schrödinger's time dependent equation for matter waves. [5mks]

c). White light is incident on a soap film at an angle  $\sin^{-1}(4/5)$  and the reflected light is observed with a spectroscope. It is found that two consecutive dark bands correspond to wavelength  $6100 \text{ \AA}$  and  $6000 \text{ \AA}$ . If the refractive index of the film is  $4/3$ , calculate its thickness. [5mks]

Q5 a) Find the de Broglie wavelength of (i) an electron accelerated through a potential difference of 182 Volts and (ii) 1 Kg object moving with a speed of 1 m/s. Comparing the results, explain why is the wave nature of matter not apparent in daily observations? [5mks]

b). Derive an expression for interplanar spacing in a cubic unit cell? [5mks]

c) Explain the principle and working of Supercapacitors? [5mks]

Q6a) Explain principle, construction and working of Light Emitting Diode? [5mks]

b). State Meissner's effect. Show that superconductors exhibit perfect diamagnetism [5mks]

c). We wish to coat a flat slab of glass with refractive index 1.5 with a thinnest possible film of transparent material so that light of wavelength 600 nm incident normally is not reflected. We have two materials to choose from  $M_1$  ( $\mu = 1.21$ ) and  $M_2$  ( $\mu = 1.6$ ). Which one would be appropriate? What will be the minimum thickness of coating? [5mks]

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