**(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]

a. Draw the following planes in a cubic unit cell (121), (100), (011).

b. The diameter of $5^{th}$ dark ring in Newton's ring experiment was found to be 0.42 cm. Determine the diameter of $10^{th}$ dark ring in the same set up.

c. An electron is bound in a one-dimensional potential well of width 2 A° but of infinite height. Find its energy values in the ground state and in first excited state.

d. Define superconductivity and explain the terms critical temperature and critical magnetic field.

e. Find the resistivity of intrinsic germanium at 300 K. Given density of carriers is $2.5 \times 10^{19}$ /$m^3$, mobility of electrons is 0.39 $m^2$/volt-sec and mobility of holes is 0.19 $m^2$/volt-sec.

f. What are matter Waves? State three properties of matter waves.

g. 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 $3.6 \times 10^{-4}$ $m^3$/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° C. The band gap energy is 1.12 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 A° and 6000 A°. 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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