

05/06/2025 FE ALL BRANCHES SEM-I C-SCHEME EP-I QP CODE: 10085924

(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.

- Q.1 Attempt any **FIVE** (15)
- Calculate electron in intrinsic silicon at room temperature if its electrical conductivity is  $4 \times 10^{-4}$  mho/m. given mobility of electron =  $0.14 \text{ m}^2/\text{V-sec}$ .
  - Draw the following with reference to cubic unit cell: (111), (100) and (011)
  - Explain why an extensively thin film appears black in reflected light.
  - What is the physical significance of wave function  $\psi$  of matter waves?
  - Explain at least three applications of super capacitors.
  - What is mesomorphic state of matter?
  - Explain phase velocity, group velocity & wave packet of matter waves.
- Q.2 (a) What is thin film? Derive the conditions for maxima & minima due to interference of light reflected from thin film of uniform thickness (08)
- (b) Explain with neat diagram construction of Bragg's X-ray spectrometer and explain the procedure to determine crystal structure using it. Calculate the maximum order of diffraction if x-ray of wavelength  $0.819 \text{ \AA}$  is incident on a crystal with lattice spacing of  $0.282 \text{ nm}$ . (07)
- Q.3 (a) Discuss Heisenberg's Uncertainty principle and prove that electrons cannot reside inside the nucleus of an atom using the same principle. (08)
- (b) What is photovoltaic effect? Explain the principle, working & applications of solar cell. (07)
- Q.4 (a) The resistivity of intrinsic InSb at room temperature is  $2 \times 10^{-4} \text{ Ohm-cm}$ . If the mobility of hole is  $0.2 \text{ m}^2/\text{V-s}$  & mobility of electron is  $6 \text{ m}^2/\text{V-s}$ . Calculate its intrinsic carrier density. (05)
- (b) Derive one dimensional time dependent Schrödinger wave equation for matter wave. (05)
- (c) A wedge-shaped film of solution which had refractive index 1.28 was observed normally. The distance between successive bands was  $0.15 \text{ cm}$ . The angle of wedge was  $0.01^\circ$ . Determine the wavelength of light used. (05)

- Q.5 (a) Explain the function & construction of super capacitors in detail (05)
- (b) What is Fermi level and Fermi energy? Write Fermi-Dirac distribution function (05)
- (c) Show that group velocity of matter waves is equal to particle velocity. (05)
- Q.6 (a) Distinguish between Type I and Type II superconductors. (05)
- (b) Find the minimum thickness of the soap film which appear yellow (wavelength  $5896 \text{ \AA}$ ) in reflection when it is illuminated by white light at an angle of  $45^\circ$ . Given refractive index of the film is 1.33. (05)
- (c) If the uncertainty in position of an electron is  $4 \times 10^{-10} \text{ m}$ , calculate the uncertainty in its momentum (05)
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