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E – 3869

Reg. No. : .....

Name : .....

IV Semester M.Sc. Degree Examination, July 2018

Branch : Physics

PH 241 : CONDENSED MATTER PHYSICS

(2014 Admission Onwards)

Time : 3 Hours

Max. Marks : 75

PART – A

Answer **any five** questions. **3** marks **each**.

- I. a) Explain polymorphism in crystals.
- b) Explain how the anharmonic crystal interactions explains thermal expansion.
- c) Discuss the concept of “effective mass” of an electron.
- d) Explain the phenomenon of Hall effect in semiconductors.
- e) Show that the Larmor frequency is proportional to applied magnetic field.
- f) Explain the properties of ferroelectric crystals.
- g) What is meant by London penetration depth ?
- h) Give the principle of Atomic force microscopy.

PART – B

Answer **all** questions. **15** marks **each**.

- IIA. a) Explain the concept of reciprocal lattice. Obtain expressions for the reciprocal lattice vectors.
- b) Discuss the Debye model for lattice heat capacity.

OR

- IIB. a) Describe the effect of temperature on Fermi distribution function.
- b) Discuss the outcome of Kronig-Penny model. How does it explain the formation of energy bands in solids ?

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- IIIA. a) Derive an expression for the density of electrons in the conduction band of an intrinsic semiconductor.  
b) What are the different sources of polarizability ? Explain the variation of total polarizability with frequency.

OR

- IIIB. a) Obtain an expression for the paramagnetic susceptibility of a material using quantum theory.  
b) Explain the hysteresis curve on the basis of domain theory.
- IVA. a) Discuss the effect of magnetic field on the superconducting state of a material.  
b) Give the formulation of AC Josephson effect and show that the current density across the AC Josephson junction is oscillatory.

OR

- IVB. a) Describe the sol gel technique for the synthesis of nanomaterials.  
b) Explain the working principle of a transmission electron microscope.

### PART – C

Answer **any three** questions. **5 marks each**.

- V. a) Find the inter-planer spacing for (321) plane in a simple cubic lattice with lattice constant  $4.2 \times 10^{-8}$  cm.  
b) Compute the cut-off frequency for a linear monoatomic lattice of interatomic distance  $3 \times 10^{-10}$  m, if the velocity of sound is  $3 \times 10^3$  m/s.  
c) Calculate the Fermi energy of sodium metal if its atomic radius is  $1.86 \text{ \AA}$ .  
d) An electric field of  $100 \text{ V/m}$  is applied to a n-type semiconductor having hall coefficient  $-0.0125 \text{ m}^3/\text{C}$ . Determine the current density in the sample if the electron mobility is  $0.36 \text{ m}^2\text{V}^{-1}\text{s}^{-1}$ .  
e) Estimate the order of magnitude of the exchange integral for a cubic structured ferromagnet having Curie temperature  $727^\circ\text{C}$ . Also calculate the internal field. Given  $\mu_B = 9.3 \times 10^{-24} \text{ J/T}$ .  
f) The critical temperature for Hg with isotopic mass 199.5 is 4.18 K. Calculate the critical temperature for an isotopic mass 203.4.
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