UG/5th Sem/Phys(H)/T/19

2019

B.Sc. (Honours)

5th Semester Examination

PHYSICS

Paper - C12T

Full Marks : 40 Time : 2 Hours

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

1. Answer any *five* questions from the following : 2×5=10

(a) A metal has a static conductivity of 4×10^7 mho/m. Assuming that the true charge carries are free electrons and they are 2×10^{28} in number per m^3, calculate the relaxation time.

(b) Differentiate between Type-I and Type-II superconductors.

(c) Show that for as 1D mono-atomic lattice the group velocity at the zone boundary is zero.

[Turn Over]

(d) The paramagnetic susceptibility of a material which has 10^{28} atoms/m^3 is 2.8×10^{-4} at 350K. Calculate its susceptibility at 300K.

(e) What is the basic difference between a crystalline solid and amorphous solid ? 2

(f) For the first allowed energy band in a crystalline solid, plot qualitatively the variation of energy E and the effective mass m^* with the wave number k. 2

(g) Consider X-rays of wavelength 1.54×10^{-10} m incident on a simple cubic crystal of lattice constant 4.0×10^{-10} m. Calculate the glancing angle for the first order reflection. 2

(h) What is Meissner effect ? 2

2. Answer any *four* questions from the following : 5×4=20

(a) Write down the Laue's equations for X-ray diffraction from a crystalline solid and obtain Bragg's law from Laue's equation. How does Laue approach differ from the Bragg approach ? 1+3+1

(b) In a 1D lattice

(i) Write down the expressions of the maximum and the minimum frequencies for the acoustic and optical branches considering lighter mass as 'm' while heavier mass as 'M'. 2

(ii) Find the widths of both the branches when $m \ll M$ and the ratio of widths. 2

(iii) What is phonon ? 1

(c) Explain hysteresis in ferromagnetic materials from Weiss domain theory. 5

(d) Show that the effective mass of an electron in a crystal is given by

$$m^* = \hbar^2 \Big/ \left(\frac{d^2E}{dk^2} \right)$$

where the symbols have their usual meanings.

The energy of an electron in a band is given by $E = E_1 - E_2 \cos(ka)$, where E_1, E_2 and a are constants. Find the effective mass in the band. 5

[Turn Over]

(e) What is Hall effect ? Find Hall coefficient in a metal. Why is the Hall coefficient positive in some metals ? 1+3+1

(f) Show that the number of possible wave functions in any energy band is equal to the number of unit cells. 5

3. Answer any *one* question from the following : 10×1=10

(a) (i) Write down basic assumptions behind Langevin's theory of paramagnetism. 1

(ii) Derive the expression for the total magnetisation. 3

(iii) Discuss the characteristics of Langevin function for low and high magnetic fields. 2

(iv) Hence find the Curie's law of paramagnetism. 2

(v) Give the physical significance of real and imaginary parts of refractive index of a material. 2

(a) (i) Define atomic scattering factor and geometrical structure factor. 2+2

(ii) Obtain Clausius-Mosotti equation relating macroscopic dielectric constant with microscopic polarizabilities. An elemental dielectric material has dilectric constant 12 and it contains 5×10^{28} atoms/m^3. Calculate its electronic polarizability. 4+2
