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Name.....

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Reg. No.....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2015

(CUCSS)

Physics

PHY 3C 11—SOLID STATE PHYSICS

(2012 Admission onwards)

Time : Three Hours

Maximum : 36 Weightage

Part A

Answer all questions.

Each question carries 1 weightage.

1. What are Miller indices ? How are they determined ?
2. What is the structure of Germanium and Silicon ? How many molecules per unit cell are there ?
3. What is the difference between a crystal lattice and reciprocal lattice ?
4. Explain Ionic cohesive energy.
5. Define relaxation time and collision time of free electrons in metals.
6. What is an infinite potential well ?
7. What are Brillouin zones ? How are they related to the energy of an electron in a metal ?
8. Explain Neel's theory of antiferromagnetism.
9. Distinguish between hard and soft magnetic materials.
10. What are ferrites ? In what ways are they superior to ferromagnetic materials ?
11. What are cooper pairs ? Where are they formed ?
12. At what temperature the band gap of a superconductor vanish ? Why ?

(12 × 1 = 12 weightage)

Part B

Answer any two questions.

Each question carries 6 weightage.

1. Explain Packing density or packing factor in crystals. Show that the packing factor for bcc and fcc structures are $\sqrt{3}\pi/8$ and $\sqrt{2}\pi/6$ respectively.
2. Deduce Weidmann and Franz law. Explain its significance.

Turn over

3. Discuss the Kronig-Penney model for the motion of an electron in a periodic potential. What is meant by density of energy states ?
4. Derive the London equations and explain how its solutions accounts Meissner effect.

(2 × 6 = 12 weightage)

Part C

Answer any **four** questions.

Each question carries 3 weightage.

1. Prove that the reciprocal lattice for a bcc lattice is a fcc structure.
2. Show that the number of Frenkel defects in equilibrium at a given temperature is proportional to $(NN_2)^{1/2}$ where N is the number of atoms and N_2 be the interstitial atoms.
3. Calculate the Debye temperature for diamond given Young's modulus = 10^{12} N/m² and density = 3500 kg/m³.
4. The critical temperature T_c for mercury with isotopic mass 199.5 is 4.185 K. Calculate the critical temperature when its isotopic mass changes to 203.4.
5. What is a Bohr Magneton ? A typical magnetic field achievable with an electromagnet with iron core is 10^4 G. Compare the magnetic interaction energy μH of an electron spin magnetic dipole moment with $K_B T$ at room temperature and show that at ordinary temperature the approximation

$$\frac{K_B T}{\mu H} \gg 1 \text{ is valid.}$$

6. What is London Penetration depth ? The London Penetration depths for Pb at 3 K and 7.1 K are respectively 39.6 nm and 173 nm. Calculate its transition temperature as well as Penetration depth at 0K.

(4 × 3 = 12 weightage)