

Seat No. : _____

AT-127

May-2016

M.Sc., Sem.-II

409 : Physics

(Solid State Properties and Physics of Semiconductor)

Time : 3 Hours]

[Max. Marks : 70

- Instructions :** (1) Attempt **all** questions.
(2) Symbols used have their usual meanings.
(3) Assume data when necessary.

1. (A) Obtain the expression of the stabilization free energy density for the superconducting state. 7

OR

What do you mean by tunneling ? Explain in details DC Josephson effect.

- (B) Write down the London equation and show that the magnetic field decays exponentially in a superconductor. Also using the concept of coherence length, derive the dirty superconductor limit. 7

OR

Show that the magnetic flux is quantized in unit of $h/2e$.

2. (A) What is magnetic resonance ? Discuss Electron Spin Resonance in detail. 7

OR

Write notes on :

- (1) Spin-Lattice relaxation
(2) Spin-Spin relaxation

- (B) Discuss the Weiss theory of Ferromagnetism. 7

OR

Discuss the Neel model of antiferromagnetism.

3. (A) Define generation and recombination. Show that during the recombination process excess charge carrier density in an n -type semiconductor decays exponentially with time. 7

OR

Discuss the Hall effect. State its applications.

- (B) (i) Explain the effect of temperature on the Fermi level in an n -type semiconductor. 4
- (ii) Mobilities of electrons and holes in a sample intrinsic germanium at 300 K are $0.36 \text{ m}^2\text{V}^{-1}\text{S}^{-1}$ and $0.17 \text{ m}^2\text{V}^{-1}\text{S}^{-1}$, respectively. If the conductivity of the specimen is $2.12 \text{ } \Omega^{-1} \text{ m}^{-1}$. Estimate the forbidden energy gap. (Take $K_1 = 4.8 \times 10^{21}$ and Boltzmann constant $k = 8.6 \times 10^{-5} \text{ eV}$) 3
- OR**
- What is density of states ? Obtain an expression of density of states for a metal and extend it to find a similar equation for a semiconductor. 7
4. (A) Differentiate between an abrupt and graded p - n junction. Derive the rectifier equation for p - n junction. 7
- OR**
- For an abrupt p - n junction, derive an equation for the depletion layer width. Assume that no external bias is applied to the junction.
- (B) Draw energy band diagram when two metals are joined. Explain the concept of contact potential. State the physical significance of such potential. 7
- OR**
- What is junction capacitance ? Obtain an expression of the junction capacitance when an external bias is applied to it.
5. Answer the following in brief : (Each carry **one** mark) 14
- (1) Calculate the stabilization free energy of Aluminium with $B_{ac} = 85 \text{ Gauss}$.
 - (2) Give an example of isotope effect in superconductivity.
 - (3) How cooper pairs are formed in superconductor ?
 - (4) Which magnetic substance possesses no net magnetic moment even in the presence of external magnetic field ?
 - (5) What is the meaning of anisotropy energy ?
 - (6) Write the chemical formula for ferrites.
 - (7) Write the magnon dispersion relation for ferromagnetic and anti-ferromagnetic substance.
 - (8) Why the location of donor state is close to the bottom of the valance band ?
 - (9) Draw a schematic Fermi level diagram of a p -type semiconductor kept at 20° and 90° C .
 - (10) State the significance of law of mass action.
 - (11) Draw the band diagram of a typical p - n junction.
 - (12) What do you mean by thermoionic emission ?
 - (13) Why “trap” is required for recombination process in semiconductor ?
 - (14) Define avalanche breakdown.