

Attempt any **FOUR** Questions. State the meaning of variable used. Draw the diagram where required.

### SECTION I

- 1- a) Describe different Types of Nanostructure Materials. 3  
 b) Explain Hall's effect and Hall's coefficient? Write down the Applications of this effect. 6  
 c) A particle is in a 3-Dimensional box with  $L_3 = L_2 = 2L_1$ . Give Quantum Nos.  $n_1$ ,  $n_2$  and  $n_3$  that correspond to the lowest quantum states of this box. 3.5
  
- 2- a) Define Degeneracy. How it can be removed? 3  
 b) Distinguish between Fermi Energy and the Ground State Energy. 3  
 c) Estimate the electronic contribution of specific heat 'kmol' of copper at 4 K and 300 K. the Fermi energy of copper is 7.05 eV and is assumed to be temperature independent. 6.5
  
- 3- a) Define Magnetic Moment. Describe different Sources of Magnetic Moment. 4  
 b) Distinguish between Classical and Quantum Mechanical approaches of Paramagnetic materials. Which one is better and why? 5.5  
 c) You are given a Magnetic Material. How you'll distinguish that it is a Para, Dia, Ferro or Antiferro Magnetic Material. 3

### SECTION II

- 4- a) Discuss the Direct and Indirect optical absorption in Semiconductor. 6  
 b) Explain the Semi Classical Model for the Electrical Conduction in Metals. 6.5
  
- 5- a) How the p-type and n-type impurity modify the Fermi level in Semiconductors? 2  
 b) Derive an equation for charge density  $\rho(x)$  due to impurities and current carriers in a P-N Junction. 4  
 c) Use the equation in part (b) to write down the Poisson equation for the region inside the depletion layer. Hence derive formula for the width of the depletion layer on the N side and P side. 6.5
  
- 6- Write comprehensive notes on the following: 6, 6.5  
 a) Effective Mass  
 b) Tight Binding Method