

- N.B. :** (1) Question. 1 is **compulsory**.  
 (2) Attempt any **three** questions from the remaining questions No. 2 to 6.  
 (3) **Assume** suitable **data** wherever required.  
 (4) **Figures** to the **right** indicate **marks**.

1. Attempt any **five** questions from the following-

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- What are crystal imperfections? Mention any two significance of it.
- Write schrodinger's time dependent and time independent wave equations of matter waves in one dimension and state physical significance of these equations.
- Draw the I-V characteristics of a photo-diode. What is meant by dark current?
- Define super conductivity and critical temperature. Plot the variation of resistance versus temperature in case of superconducting state of the material.
- What is reverberation time? Discuss sabine Formula
- State 'magnetostriction effect.' Mention any two applications of ultrasonic waves.
- Calculate conductivity of a germanium sample if a donor impurity atoms are added to the extent to one part in  $10^6$  germanium atoms at room temperature.

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Assume that only one electron of each atom takes part in conduction process.

Given: Avogadro's number-  $6.023 \times 10^{23}$  atoms/gm - mole

Atomic weight of Ge=72.6

Mobility of electrons =  $3800 \text{ cm}^2/\text{volts sec}$ .

Density of Ge =  $5.32 \text{ gm/cm}^3$

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- Describe with necessary theory the Davisson and Germer experiment establishing wave nature of electrons. calculate the de-broglie wavelength of an alpha particle accelerating through a potential difference of 200 volts  
Given- Mass of alpha particle =  $6.68 \times 10^{-27} \text{ kg}$ .
  - Define the terms drift current and mobility of a charge carriers. Calculate the current product in a germanium sample of area of cross section  $1 \text{ cm}^2$  and thickness of  $0.01 \text{ m}$ , when a potential difference of  $2 \text{ V}$  is

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applied cross it. Given- The concentration of free electrons in germanium is  $2 \times 10^{19}/\text{m}^3$  and mobilities of electrons and holes are  $0.36 \text{ m}^2/\text{volts sec}$  and  $0.17 \text{ m}^2/\text{volts sec}$  respectively.

3. (a) Draw and explain the unit cell of sodium chloride (NaCl) crystal. Determine effective number of NaCl molecules per unit cell and co-ordination number. 8
- (b) State applications of Hall effect. In a Hall effect experiment a potential difference of  $4.5 \mu\text{V}$  is developed across a foil of zinc of thickness  $0.02 \text{ mm}$ , when a current of  $1.5\text{A}$  is carrying in a direction perpendicular to applied magnetic field of  $2 \text{ tesla}$ . Calculate 7
  - (a) Hall coefficient for zinc www.muadda.com
  - (b) Concentration of electrons
4. (a) Discuss formation of cooper pairs and energy gap in superconductor on the basis of BCS theory. 5
- (b) State any five factors affecting the acoustics of the building and give the remedies for each. 5
- (c) An ultrasonic pulse of  $0.09 \text{ MHz}$  sends down towards the sea-bed which returns after  $0.55 \text{ seconds}$ . The velocity of ultrasonic waves in sea water is  $1800 \text{ m/sec}$ . Calculate the depth of sea and wavelength of ultrasonic pulse. 5  
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5. (a) How does the position of Fermi energy level changes with increasing doping concentration in p-type semi-conductors? sketch the diagram. 5
- (b) Explain analysis of crystal structure using Bragg's X ray spectrometer. 5
- (c) Find the minimum energy of neutron confined to a nucleus of size of the order of  $10^{-14} \text{ m}$ . 5  
Given mass of neutron =  $1.675 \times 10^{-27} \text{ kg}$ .
6. (a) Calculate the critical radius ratio of an ionic crystal in ligancy -6. What is the maximum size of cation in ligancy-6 configuration, when size of anion is  $2.02\text{\AA}$ ? 5  
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- (b) What do you mean by group and phase velocity? Show that the de-Broglie group velocity associated with the wave packet is equal to the velocity of the particle. 5
- (c) Explain the formation of potential barrier across the unbiased p-n junction region. 5