2016

ELECTRONICS

(Major)

Paper : 1.1

(Material Science)

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Write 'Yes' or 'No' of the following : 1×7=7

(a) Resistance of copper decreases with increase in temperature.

(b) Probability of occupancy at energy E for a hole is $1+F(E)$, $F(E)$ being the Fermi factor.

(c) Drift and diffusion are classical processes of electron transport in semiconductor materials.

(d) Excitation energy for photo-luminescence in pure semiconductor must be less than the band gap energy.

(e) Solar cell materials must possess high efficiency for photoluminescence.

(f) Fermi level in a degenerate *p*-type semiconductor lies in the conduction band.

(g) Vacuum tube devices, viz., diode, triode, tetrode and pentrode are macro-electronic devices.

2. Answer the following questions : 2×4=8

(a) Give a schematic diagram for the structure of a tetrode with proper labelling.

(b) Distinguish between ionic and covalent bonds.

(c) Write briefly on superconducting materials.

(d) What do you mean by degenerate and nondegenerate semiconductors?

3. Answer any *three* of the following questions : 5×3=15

(a) Deduce Einstein's relation between diffusion coefficient and mobility of a charge carrier in semiconductor. 5

(b) Write down the general characteristics of electrical conduction in metal. 5

(c) What is electroluminescence? Describe a device based on electroluminescence. 2+3=5

(d) Direct band gap semiconductors are suitable for optoelectronic devices. Justify. 5

(e) Calculate the intrinsic carrier concentration in gallium arsenide at $T = 300$ K and at $T = 450$ K. Give a comment on the results obtained. 4+1=5

4. Answer any *three* of the following questions : 10×3=30

(a) Describe Langevin's theory of paramagnetism. What is Curie constant? 8+2=10

(b) Explain, with suitable diagrams, the conduction band, valence band and forbidden gap, and hence explain the behaviour of conductors, insulators and semiconductors. Discuss the contribution of electrons and holes to electrical conduction. (4+4)+2=10

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(c) What is Hall coefficient? Show that, for a p-type semiconductor, the Hall coefficient (R_H) is given by

$$R_H = \frac{1}{pe}$$

(Symbols have their usual meanings.) Describe an experimental setup for the measurement of the Hall voltage. 2+4+4=10

(d) Derive expressions for the densities of electrons and holes in the conduction and valence bands respectively in an intrinsic semiconductor. Show that the Fermi level in an intrinsic semiconductor lies approximately halfway in the forbidden gap. 6+4=10

(e) Develop the concept of holes and effective mass from the energy band theory of semiconductor. 5+5=10

(f) Write short notes on the following : 5+5=10

(i) Crystal defects

(ii) Solar cell materials

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