M.Sc. 2nd Semester Examination, 2011

ELECTRONICS

(*Electronic Materials*)

PAPER—ELC-203

(Theory)

Full Marks : 40

Time : 2 hours

Answer **Q. No. 1** and any **three** from the rest

The figures in the right-hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

Illustrate the answers wherever necessary

1. Answer any *five* questions : 2 × 5

(*a*) Classify different imperfections in crystals.

(*b*) Explain drift mobility and Hall mobility of charge carriers.

(*c*) Why does the field seen by the dipoles in a solid differ from the applied field?

(*d*) What are Cooper pairs?

(*e*) Stoichiometric ZnO is an insulator but non-stoichiometric ZnO is an *n*-type semiconductor. Explain.

(*f*) What type of material do you choose for a solar cell and why?

2. (*a*) Derive the equation relating the number of vacancies n found in a monoatomic crystal to the energy E_a required to remove one atom to the crystal's exterior.

(*b*) Calculate the ratio of number of vacancies in equilibrium at 300 K in Al to that produced by rapid quenching from 800 K. Enthalpy of formation of vacancies in Al is 68 kJ mol^{-1}.

(*c*) Explain tilt boundary and twin boundary crystal imperfections.

$$4+3+\left(1\frac{1}{2}+1\frac{1}{2}\right)$$

3. (*a*) Establish the Boltzmann transport equation (BTE).

(*b*) With the help of BTE show that the electrical conductivity of a free electron gas is $\sigma = ne^2\tau/m$, where the symbols have their usual meanings. 5 + 5

4. (*a*) What is Hall effect? Find the Hall coefficient for an intrinsic semiconductor.

(*b*) The electron and hole mobilities in a semiconductor are $0{\cdot}8\ m^2V^{-1}s^{-1}$ and $0{\cdot}02\ m^2V^{-1}s^{-1}$ respectively. The electron concentration in the semiconductor is $2{\cdot}5 \times 10^{18} m^{-3}$ and the Hall coefficient is zero. Calculate the intrinsic carrier concentration.

(*c*) Explain a quantum well structure. (2 + 3) + 2 + 3

5. (*a*) What are the different contributions to the total polarization of a dielectric material?

(*b*) Why does the static dielectric constant in alkali halides differ from the high frequency dieletric constant? What is the physical significance of complex dielectric constant?

(*c*) Si has the dielectric constant 12, and the edge-length of the conventional cubic cell of Si lattice is 5·43 Å. Calculate the electronic polarizability of Si atoms. 3 + (2 + 2) + 3

6. Write notes on any *two*: 5 × 2

(*i*) Josephson effect

(*ii*) Photoconductor

(*iii*) Materials for VLSI.