Jharkhand University of Technology, Ranchi

B.Tech. 1st Semester Examination, 2018

Subject : Physics-I(Semiconductor Physics) **Subject Code : 18103**

Time Allowed : 3 Hours **Full Marks : 70**

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

The figures in the margin indicate full marks.

Answer any five *questions.*

1. Answer the following multiple choice questions: 2×7=14

(i) In intrinsic semiconductor Fermi level is

(a) near the top of the valence band
(b) near the bottom of the conduction band
(c) at the centre of the energy band gap
(d) None of the above

(ii) In the case of n-type semiconductor the Fermi level is given by

(a) $E_F = E_C + KT.ln\frac{N_C}{N_D}$
(b) $E_F = E_C - KT.ln\frac{N_C}{N_D}$
(c) $E_F = E_C + KT.ln\frac{N_D}{N_C}$
(d) None of the above

where terms have usual meanings.

(iii) The density of state function around energy E in a metal is

(a) Proportional to $E^{\frac{1}{3}}$
(b) Proportional to $E^{\frac{1}{2}}$
(c) Proportional to E^2
(d) None of the above

(iv) The density of state function around energy E in one dimensional system, assuming zero potential energy is

(a) $N(E) = \frac{(2m_e^*)^{\frac{1}{2}}}{\pi\hbar}E^{\frac{1}{2}}$
(b) $N(E) = \frac{(2m_e^*)^{\frac{1}{2}}}{\pi\hbar}E^{\frac{-1}{2}}$
(c) $N(E) = \frac{\pi\hbar}{(2m_e^*)^{\frac{1}{2}}}E^{\frac{1}{2}}$
(d) None of the above

where terms have usual meanings.

(v) The unit of photon absorption coefficient is the number of photons absorbed

(a) per centimeter

(b) per square centimeter

(c) per cube centimeter

(d) None of the above

(vi) The Hall mobility (μ_H) is equal to

(a) $\frac{R_H}{\sigma}$

(b) $\frac{\sigma}{R_H}$

(c) $\sigma . R_H$

(d) None of the above

where terms have usual meanings.

(vii) GaAs is a

(a) indirect band gap material

(b) direct band gap material

(c) Both of the (a) and (b)

(d) None of the above

Or,

1. Discuss the energy band diagram of a solid crystal and hence distinguish between metal, semiconductor and insulator. 14

2. Discuss with the help of neat diagram n-type & p-type extrinsic semiconductors and hence explain how does Fermi level change in presence of donor and acceptor impurities. 14

3. Discuss with the help of neat sketch the energy band diagram of an open circuited p-n junction diode and hence obtain an expression for the barrier height.

   A p-n junction has doping densities $N_A = 5 \times 10^{18} cm^{-3}$ and $N_D = 5 \times 10^{15} cm^{-3}$ in the two regions. Assuming $n_i = 1.5 \times 10^{10} cm^{-3}$ and at room temperature (300k) the thermal voltage is 0.026 volt. Calculate the built-in potential at the room temperature. 14

4. Derive an expression for maximum power output of a photovoltaic cell and hence obtain the expression for conversion efficiency. 14

5. Discuss qualitatively the volt-ampere characteristics of a p-n junction diode and hence explain how you will extract the different diode parameters from the characteristics. 14

6. What is a quantum wire? Derive an expression for density of states in one dimensional system. How does this expression modify for quantum wire? 7×2=14

7. Write notes on *any two* of the following: 7×2=14

   (a) Hot point probe measurement

   (b) Direct and indirect band gaps

   (c) Metal-semiconductor junction (ohmic)

   (d) Effective mass
