2021 Sir Batch

Branch = IT

First Semester.

End Sem

101

Time : 3 hours

Full Marks : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

(ii) There are ***NINE*** *questions in this paper.*

(iii) Attempt ***FIVE*** *questions in all.*

(iv) Question No. ***1*** *is compulsory.*

(v) Symbols used (if any) have their usual meanings.

1. Answer any *seven* questions : 2×7=14

(a) A doped semiconductor has 10 billion silicon atoms and 15 million pentavalent atoms. If the ambient temperature is 25 °C, how many free electrons are there inside the semiconductor?

(b) Define direct band semiconductors.

(c) Define Fermi level.

9. *(a)* X-rays with an energy of 300 keV undergo Compton scattering with a target. If the scattered X-rays are detected at 30° relative to the incident X-rays, determine the Compton shift at this angle. 6

(b) Write short notes on *(i)* expectation values and *(ii)* energy bands in solids. 8

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(d) Define radiative recombination.

(e) What do you mean by population inversion?

(f) Draw *I-V* characteristics of a *p-n* junction in forward bias.

(g) Find the de Broglie wavelength of a 4 g golf ball moving with a velocity of 30 m/s.

(Planck's constant $= 6 \cdot 63 \times 10^{-34}$ Js)

(h) State Heisenberg uncertainty principle.

(i) Define drift velocity.

(j) There are two absolutely identical objects *A* and *B* in appearance, shape and size. One of them is made up of semiconducting materials while the other is of metal. How would you differentiate these?

2. Discuss the dependence of Fermi level in an *n*-type semiconductor on carrier concentration and temperature. 14

3. Discuss the Kronig-Penny model for the motion of an electron in a periodic potential. From the results obtained, plot the relation between the energy and wave number (E-k diagram) of a one-dimensional lattice. 10+4=14

4. Discuss LED including its structure, material used, characterization and figure of merit. 14

5. (a) Write short notes on (i) carrier generation and (ii) phonons. 6

(b) Assume silicon (bandgap 1·12 eV) at room temperature (300 K) with the Fermi level located exactly in the middle of the bandgap. What is the probability that a state located at the bottom of the conduction band is filled? What is the probability that a state located at the top of the valence band is empty? 8

6. (a) Discuss rate of equation for carrier and photon density. 7

(b) Discuss semiconductor LASER— structure and materials. 7

7. Discuss photodetectors in detail. Also discuss current-voltage (reverse and forward bias) characteristics of PIN diode. 7+7=14

8. What is the physical significance of wave function? Derive time-dependent and time-independent Schrödinger's equations. 14