BRAINWARE UNIVERSITY

Term End Examination 2023-2024
Programme – B.Tech.(CSE)-DS-2022/B.Tech.(CSE)-2023
Course Name – Semi-Conductor Physics/Semiconductor Physics
Course Code - BSCD201/BSCG201
(Semester II)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A
(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) Identify the correct relation between total energy [E] and temperature [T] in Stefan-Boltzmann law

a) $E \propto T^4$ b) $E \propto T^{-4}$
c) $E \propto T$ d) $E \propto T^{-1}$

(ii) In Relativistic case, as the velocity of the particle approaches the speed of light, the predicted kinetic energy will approach

a) zero b) kinetic Energy as in Non-Relativistic case
c) rest energy d) infinite

(iii) As a radiator, the black body emits thermal radiation _____

a) at a constant single wavelength b) at the maximum wavelength
c) at all wavelengths d) none of the above

(iv) For the function $e^{\beta^2 x}$, evaluate the eigen value of the operator $\frac{d^2}{dx^2}$

a) β b) β^2
c) β^3 d) β^4

(v) What is the correct form of Wiedemann-Franz law?

a) $\frac{\sigma_T}{\sigma} = LT$ b) $\frac{\sigma}{\sigma_T} = LT$

c) $\frac{\sigma_T}{\sigma} = \frac{L}{T}$

d) $\frac{\sigma}{\sigma_T} = \frac{T}{L}$

(vi) Determine the type of a material if its band gap is more than 5 eV.

a) Superconductor
b) Insulator
c) Semiconductor
d) Conductor

(vii) Quantum free electron theory was developed by_____.

a) Drude
b) Sommerfeld
c) Lorentz
d) Hall

(viii) Addition of pentavalent impurity to an intrinsic semiconductor creates many _____ .

a) Holes
b) Free electrons
c) Valence electrons
d) Bound electrons

(ix) With increasing forward bias to a p-n junction, the width of depletion layer _____ .

a) decreases
b) increases
c) remains the same
d) intially increases then decreases

(x) The leakage current across a p-n junction is due to the _____ .

a) Junction capacitance
b) Majority carriers
c) Ions
d) Minority carriers

(xi) In a ruby laser, population inversion is achieved by _____.

a) optical pumping
b) inelastic atom-atom collision
c) chemical reaction
d) applying strong electric field

(xii) What is the wavelength of output of the He-Ne laser?

a) 632.8 nm
b) 600 nm
c) 532.8 nm
d) 500 nm

(xiii) Which of the following parameter can not be determined from the Hall effect experiment?

a) Type of charge carrier
b) Mobility
c) Carrier concentration
d) Temperature

(xiv) Merit of four-point probe method of determining resistivity is that _____.

a) it gives the resistivity at a localized region of the sample
b) it injects excess minority carriers
c) it needs very small current
d) it gives the average resistivity of the sample

(xv) For a graded index optical fiber, the refractive index of core to cladding _____ .

a) gradually increases
b) gradually decreases
c) increases by step
d) decreases by step

Group-B

(Short Answer Type Questions) 3 x 5=15

2. Distinguish between direct and indirect band gap semiconductors (3)

3. Calculate the numerical aperture and acceptance angle of a given optical fibre if the refractive indices of the core and the cladding region are 1.562 and 1.497, respectively. (3)

4. The maximum uncertainty in the position of an electron in a nucleus is 2×10^{-14} m. Calculate the minimum uncertainty in its momentum. (3)

5. Describe the following terms in the context of free electrons in metals: a) drift velocity and b) relaxation time. (3)

6. An intrinsic germanium crystal has a hole density of 10^{19} m^{-3} at room temperature. When doped with antimony, the hole density decreases to 10^{17} m^{-3} at the same temperature. Calculate the majority carrier density. (3)

OR

Estimate the diffusion co-efficient of electron in Si at 300 K if $\mu_e = 0.19\ m^2V^{-1}S^{-1}$. (3)

Group-C

(Long Answer Type Questions) 5 x 6=30

7. The Hall coefficient of a certain silicon specimen is measured as $-7.35\text{x}10^{-5}$ m^3C^{-1}. If the conductivity of the specimen is 200 $(\Omega\ m)^{-1}$, calculate the concentration and mobility of the charge carriers. (5)

8. Write down Schrödinger's equation for a free particle in a one-dimensional potential box. Applying appropriate boundary conditions calculate its eigen energies. (5)

9. Determine the normalization constant a if the wave function has the following form (5)

$$\psi(x) = \begin{cases} a\sin\frac{\pi x}{L}, & \text{for } 0 \le x \le L \\ 0, & \text{otherwise} \end{cases}$$

10. Describe the variation of the width of the depletion layer under forward and reverse biasing. (5)

11. In a He-Ne laser transition from E_3 to E_2 level gives a laser emission of wavelength 632.8 nm. If the energy of the E_2 level is 15.2×10^{-19} J, Evaluate the required pumping energy if there is no energy loss in He- Ne laser. (5)

12. Deduce the expression of the effective mass of electrons based on the Kronig-Penny Model. (5)

OR

Prove that for a system of electrons at T > 0 K obeying FD statistics, the probability that an energy level lying below the Fermi energy (E_F) is unoccupied is the same as the probability that an energy level lying above the E_F is occupied. (5)