BRAINWARE UNIVERSITY

Term End Examination 2023-2024

Programme – B.Tech.(CSE)-AIML-2021/B.Tech.(CSE)-AIML-2022/B.Tech.(CSE)-AIML-2023/B.Tech.(CSE)-DS-2023

Course Name – Semi-Conductor Physics/Semiconductor Physics

Course Code - BSCM101/BSCD101

(Semester I)

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) Choose which pair of observables of a particle cannot be measured precisely at the same time.

    a) spin and color   b) energy and torque
    c) position and momentum   d) size and speed

(ii) 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) $E \propto T^{-1}$

(iii) 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

(iv) Which of the following functions is the eigenfunction of the operator d/dx .

    a) sec(x)   b) tan(x)
    c) ln(x)   d) $e^{(-x)}$

(v) Four-point probe method is used to measure _____.

    a) Capacitance   b) Inductance
    c) Resistivity   d) Hall coefficient

(vi) Identify the total energy operator.

    a) $$-ih\frac{\partial}{\partial t}$$

    b) $$ih\frac{\partial}{\partial t}$$

c)

$$-\hbar \frac{\partial}{\partial t}$$

d)

$$\hbar \frac{\partial}{\partial t}$$

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

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

(viii) What is the primary difference between intrinsic and extrinsic semiconductors?

a) a. Intrinsic semiconductors have a higher electron concentration than extrinsic semiconductors.

b) b. Intrinsic semiconductors are pure semiconducting materials, while extrinsic semiconductors have impurities intentionally added.

c) Extrinsic semiconductors have a crystal lattice structure, while intrinsic semiconductors do not.

d) Intrinsic semiconductors conduct electricity, while extrinsic semiconductors do not.

(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 electron mobility in metals is given by _____

a) v_d/E
b) v_d/m
c) v_d/T
d) T/E

(xi) The resistivity of a material depends on which of the following factors?

a) Length of the conductor
b) Area of cross section of the conductor
c) Temperature
d) Mass of the material

(xii) The shape of E-K diagram of the conduction band and valance band is predicted to be _____ .

a) horizontal
b) vertical
c) circular
d) parabolic

(xiii) In He-Ne laser neon atoms get energy _____ .

a) on collision with He atoms
b) from chemical reactions
c) from electrical pumping
d) from optical pumping

(xiv) Population inversion in a laser system can be achieved _____ .

a) when one of the excited states is less populated than the ground state
b) when one of the excited states is more populated than the ground state
c) when the population of one excited state and the ground state are equal
d) on the basis of none of the above conditions

(xv) At $0\,K$ temperature, semiconductors are _____ .

a) Perfect metals
b) Perfect non-metals
c) Perfect insulator
d) Perfect conductors

Group-B
(Short Answer Type Questions)   3 x 5=15

2. Determine the de Broglie wavelength of a thermal neutron at temperature 600 K?   (3)

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

4. Explain the origin of negative temperature coefficient of a semiconductor. (3)

5. The error in determining the wavelength of a photon of wavelength *400 nm* is 0.0001%. Calculate the minimum uncertainty in determining its position. (3)

6. Estimate the normalization frequency of A graded index fiber, that has a core diameter of 50 μm and a numerical aperture of 0.22 at a wavelength of 850 nm. (3)

OR

Calculate the ratio of population inversion of the two states in thermal equilibrium at *300 K*. The wavelength corresponding to the energy gap between the two states is *600 nm* (3)

Group-C
(Long Answer Type Questions)

5 x 6=30

7. Evaluate the numerical aperture, acceptance angle and critical angle of a fiber having core and cladding refractive indices 1.5 and 1.45 respectively. (5)

8. Explain how a potential difference (Hall voltage) is formed in a direction perpendicular to both applied magnetic field and current. (5)

9. A light of wavelength 3000 Å falls on a metal surface of work-function 2.28 eV. Calculate the maximum speed of the ejected photoelectrons. (5)

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

11. Show that the sum of the probability of occupancy of an energy state at ΔE above the Fermi level and that at ΔE below the Fermi level is unity. (5)

12. The conductivity of intrinsic Si is 4.17×10^{-5} and 4×10^{-4} $(\Omega\,m)^{-1}$ at 0°C and 27°C respectively. Evaluate the bandgap of Si. (5)

OR

A uniform silver wire has a resistivity of 1.54×10^{-8} Ωm at room temperature. For an electric field along the wire of 1 volt cm^{-1}, compute the average drift velocity of electrons assuming that there is 5.8×10^{28} conduction electrons $/m^3$. Estimate the value of mobility. (5)

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