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BRAINWARE UNIVERSITY

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Term End Examination 2025-2026

Programme – B.Tech.(CSE)-2024/B.Tech.(CSE)-AIR-2024/B.Tech.(EE)-2024/B.Tech.
(CSE)-2025/B.Tech.(CSE)-AIR-2025

Course Name – Semiconductor Physics

Course Code - BBS00015

(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) 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) The state of a quantum system is described by its _____.

- | | |
|------------------|----------------|
| a) wave function | b) position |
| c) momentum | d) Hamiltonian |

(iii) The electron mobility is given by _____.

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

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

- | | |
|---------------------|---------------------------------------|
| a) decreases | b) increases |
| c) remains the same | d) initially increases then decreases |

(v) 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 |

(vi) Optical fiber is predominantly used in _____.

- | | |
|---------------------------|----------------------|
| a) field of communication | b) electrical wiring |
| c) agriculture | d) catalysis |

(vii) Which of the following parameters cannot be determined from the Hall effect experiment?

- | | |
|--------------------------------|----------------|
| a) Type of the charge carriers | b) Mobility |
| c) Carrier concentration | d) Temperature |

Group-C
(Long Answer Type Questions)

5 × 6 = 30

7. What do you mean by forward and reverse biasing of a p-n junction diode? Describe the variation in the width of the depletion layer when a p-n junction is subjected to forward bias and reverse bias. Which breakdown mechanism occurs in heavily doped diodes? (5)
8. In a semiconductor, a magnetic field of 0.5 T is applied to a sample with a charge carrier density of $4 \times 10^{21} \text{ m}^{-3}$. If a current of 10 mA flows through the sample and the width of the sample is 2 mm, estimate the Hall voltage. (5)
9. Find the resistance of an intrinsic germanium rod of length 1.0 cm, width 1.0 mm, and thickness 1.0 mm, at 300 K. The intrinsic carrier density is $2.5 \times 10^{19} \text{ m}^{-3}$ at 300 K, and the mobilities of the electrons and holes are $0.39 \text{ m}^2 \text{ V}^{-1} \text{ s}^{-1}$ and $0.19 \text{ m}^2 \text{ V}^{-1} \text{ s}^{-1}$, respectively. (5)
10. Write the expression for the Fermi-Dirac distribution $f(E)$ and explain each term. Draw a graph of $f(E)$ as a function of the energy E at temperature $T = 0 \text{ K}$. Calculate the occupation probability at the Fermi energy ($T \neq 0$). (5)
11. Evaluate the numerical aperture, acceptance angle and critical angle of an optical fiber having core and cladding refractive indices 1.56 and 1.51, respectively. (5)
12. What does square of the modulus of a wavefunction, $|\psi(x)|^2$ represent? Write down the mathematical condition for the normalization of a one-dimensional wave function over the region $-\infty$ to ∞ . If a particle is represented by a wavefunction $\psi(x) = Ae^{ikx}$, determine the probability density of finding the particle. (5)

OR

Describe de Broglie's hypothesis. Calculate the de Broglie wavelength of a dust particle of mass $2 \times 10^{-9} \text{ kg}$ and moving with a velocity of $3.5 \times 10^4 \text{ m/s}$. (5)

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