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Reg. No. :

Question Paper Code : 70180

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Second Semester

Mechanical Engineering

PH 3251 — MATERIALS SCIENCE

(Common to : Aerospace Engineering/Automobile Engineering/
Industrial Engineering/Industrial Engineering and Management/
Manufacturing Engineering/Marine Engineering/Mechanical Engineering
(Sandwich)/Production Engineering/Safety and fire Engineering)

(Regulations 2021)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is linear density? Calculate linear density in [110] direction of FCC unit cell.

2. What is known as polymorphism in crystal?

3. Calculate the electrical conductivity of copper, which has electron density $2 \times 10^{28}/Cm^3$ and $\tau = 10^{-4}$ second.

4. What is electron effective mass?

5. What is an indirect band gap semiconductor? Give example.

6. Distinguish drift current and diffusion current.

7. What is known as recombination in semiconductor?

8. Calculate the wavelength emission of GaAs semiconductor which has a band gap of 1.44 eV.

9. What is known as resonant tunneling?

10. What is spintronics?

PART B — (5 × 16 = 80 marks)

11. (a) (i) With neat diagram, explain BCC and FCC crystal structures. (8)

    (ii) Explain grain and twin boundary imperfections in crystals. (8)

Or

(b) (i) What is known as nucleation? (2)

    (ii) Explain homogeneous and heterogeneous nucleation processes in crystal growth. (14)

12. (a) (i) Derive the expression for density of energy states. (12)

    (ii) The intrinsic carrier concentration of Ge at 300 K is 2.37×10^{19} m^{-3}. Calculate the electrical conductivity, if electron and hole mobilities are 0.38 m^2 V^{-1}s^{-1} and 0.19 m^2 V^{-1}s^{-1} . (4)

Or

(b) (i) Explain domain theory of ferromagnetism and energies involved in domain growth. (12)

    (ii) A paramagnetic material has a magnetic field intensity of 10^4 A/m. If the susceptibility of the material at room temperature is 3.7×10^{-3}, calculate the magnetization and flux density of the material. (4)

13. (a) (i) Derive an expression for electron and hole concentration in intrinsic semiconductor. (12)

    (ii) If silicon has energy gap of 1.07 eV at 27°C, what is the probability of an electron being thermally promoted to conduction band? (4)

Or

(b) (i) Explain Hall effect phenomena and obtain an expression for Hall coefficient. (12)

    (ii) A n-type semiconductor has Hall coefficient of 4.16×10^{-4} m^3 C^{-1}. The conductivity is 108 ohm^{-1}m^{-1}. Calculate its charge carrier density n_e and electron mobility (μ_e) at room temperature. (4)

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14. (a) With neat diagram, explain optical absorption (coefficient) and various recombination processes in semiconductor.   (16)

Or

(b) Explain the construction and working of solar cell and light emitting diode with illustrations.   (16)

15. (a) Explain Quantum confinement and Quantum structures with figures. (16)

Or

(b) Explain in detail the principle of single electron transistor and its performance.   (16)

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