Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 91657

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2025.

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)/Mechanical Engineering(Specialised in Automobile)/Mechanical Engineering (Specialised in Smart Manufacturing)/Production Engineering/Safety and Fire Engineering)

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Draw the crystal plane of miller indices (110) and (010).

2. What is known as nucleation in crystal growth process?

3. Calculate the electrical conductivity of metal with relaxation time of 10^{-14} second at 300 K. The electron density is 6×10^{26} m^{-3}.

4. Define density of energy states.

5. What is band gap in semiconductor? Give two examples for indirect bandgap semiconductor.

6. The intrinsic carrier concentration of Ge at 300 K is 4.5×10^{19} m^{-3}. Calculate its conductivity if electron and hole mobilities are 0.39 m^2 V^{-1} s^{-1} and 0.19 m^2 V^{-1} s^{-1} respectively.

7. The GaAs semiconductor has band gap 1.44 eV. Calculate the wavelength emitted and mention the colour of the ray.

8. What is the principle of solar cell?

9. Define Quantum well and Quantum wire.

10. Give some examples for active and passive optoelectronic devices.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain FCC and HCP crystal structure and show that atomic packing factor of both are same. (8)

(ii) With neat illustration explain crystal imperfections. (8)

Or

(b) (i) What is known as polymorphism in crystal? (2)

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

12. (a) (i) Derive the expression for electrical conductivity and thermal conductivity of metals based on classical free electron theory of metals. (12)

(ii) A conducting rod contains 8.5×10^{28} electrons/m^3. Calculate the electrical conductivity at room temperature if the collision time for electron is 2×10^{-14} sec. (4)

Or

(b) (i) Explain ferromagnetism based on domain theory along with the energies involved in domain growth. (12)

(ii) In a magnetic material, the field strength is found to be 10^6 A/m. If the magnetic susceptibility of the material is 0.5×10^{-5}, calculate the intensity of magnetization and flux density. (4)

13. (a) (i) Derive an expression for carrier concentration in n-type semiconductor and explain the variation of Fermi level with temperature. (12)

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

Or

(b) (i) With neat diagram explain Ohmic contacts and Schottky diode. (12)

(ii) A n-type semiconductor has Hall coefficient of 0.76×10^{-4} m^3 C^{-1}. The conductivity is 100 $ohm^{-1}m^{-1}$. Calculate its charge carrier density n_e and electron mobility (μ_e) at room temperature. (4)

14. (a) Classify optical materials and explain optical absorption (coefficient), emission and various recombination processes.

Or

(b) Explain the construction and working of light emitting diode and laser diode with block diagrams.

15. (a) (i) Give two properties of carbon nanotubes. (2)

(ii) Discuss Resonant tunneling and quantum interface effects with relevant figures. (14)

Or

(b) State single electron phenomena and explain single electron transistor and its performance with figure.