

Ph. D. (PHYSICS)
(PHDPH)
Term-End Examination
June, 2026

RPHE-004 : MATERIALS SCIENCE

Time : 2 Hours

Maximum Marks : 50

Note : (i) Attempt any **five** questions.

(ii) You can use calculators. Symbols have their usual meanings.

(iii) All questions carry equal marks.

1. (a) What are solid solutions ? Explain the Hume Rothery rules governing the formation of substitution solid solutions. 2+3
- (b) What are glassy alloys ? Describe any three technological applications of glassy alloys. 2+3

2. (a) What is green compaction in powder processing ? Explain *two* methods to reduce the porosity of compacted piece.

2+3

- (b) Calculate the mass of phosphorus required to make a silicon crystal with 10^{17} cm^{-3} doping density, if the initial melt load of silicon is 50 kg. Density of molten silicon is 2.56 g cm^{-3} . Atomic weight of phosphorus is 30.97 u. Assume that the segregation coefficient k_0 is 0.35 which remains constant throughout the growth process. 5

3. (a) Describe the various modes of thin film growth. What are the factors governing the growth mode ? 6+2

- (b) What are the requirements of a material to be used as a holder for the charge in a thermal evaporation system ?

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4. (a) Calculate the equilibrium concentration of vacancies in a copper crystal at 900 K. Given that melting point of copper is 1083°C and enthalpy of vacancy formation per mole of copper is 120 kJ. 5
- (b) What are dislocation defects ? Explain their role in crystal growth. 5
5. (a) Based on the diffusion mechanisms involved explain why carbon atom diffusion is faster than nickel atom in iron lattice. 5
- (b) Draw a typical stress-strain curve of a material. Define various mechanical strengths and indicate corresponding deformation regions on this plot. 5
6. (a) What is meant by 'thermal shock' experienced by a material ? How can it be reduced ? 5
- (b) What is graphene ? Explain the bond structure of graphene on an E-k diagram. 2+3

7. (a) Explain the formation of Carbon Nano-Tubes (CNTs) and describe the bonding in CNTs. 5
- (b) What are dilute magnetic semiconductors (DMS) ? Describe their applications. 5
8. (a) Discuss any *five* forms of corrosion in materials. 5
- (b) What is the difference between organic semiconductors and inorganic semiconductors ? Explain with the help of working of organic thin film transistor (OTFT). 5

Physical Constants :

$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ eV}$$

$$h = 6.63 \times 10^{-34} \text{ Js}$$

$$k_B = 1.38 \times 10^{-23} \text{ JK}^{-1}$$

$$m_e = 9.1 \times 10^{-31} \text{ kg}$$

$$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$N_A = 6.023 \times 10^{23} \text{ mol}^{-1}$$

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