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MPHE–025

M. SC. (PHYSICS)

(MSCPH)

Term-End Examination

December, 2025

MPHE-025 : MATERIALS SCIENCE

Time : 2 Hours *Maximum Marks : 50*

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

(ii) You can use a calculator.

(iii) Symbols have their usual meanings.

(iv) Values of physical constants are given at the end.

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1. (a) Classify the materials based on their band structure. State *one* application of each. 5

(b) Explain with examples the difference between solid solution and compound structure formed when alloying element is added to a pure metal. 5

2. (a) What are glassy alloys ? Compare their mechanical properties vis-à-vis normal metal alloys and ceramic oxide materials. Write any *two* applications of glassy alloys. 5

(b) Explain the glide reflection and screw compound symmetry operations. What is the main difference between them ? 5

3. (a) Calculate the mass of phosphorus required to make a silicon crystal with

5×10^{18} cm^{-3} doping density, if the melt load of silicon is 20 kg. The density of molten silicon is 2.5 g cm^{-3} and the atomic weight of phosphorus is 30.97 u. Assume that the segregation coefficient $k_0 = 0.35$ is constant throughout the growth process. 5

(b) Describe with schematic diagram the set-up used for DC plasma sputter deposition system. 5

4. Describe the classification of defects in solids based on their dimensionality. 10

5. (a) Explain any *two* different types of gradients giving rise to diffusion in solid crystals. 5

(b) What are eutectic phase diagrams ? Draw a labelled schematic eutectic phase diagram of a binary alloy system, indicating the eutectic point, liquidus, solidus and solvus curves. 5

6. (a) Draw a typical stress-strain curve of a material. Define various mechanical strengths and indicate corresponding deformation regions on this plot. 5

(b) Define hardness of a material. Describe the method of Rockwell hardness test. 5

7. (a) Explain the process of galvanic corrosion with the help of Fe-Zn system as an example. 5

(b) What are Dilute Magnetic Semiconductors (DMS) ? How are they formed ? 5

8. (a) What are Carbon Nanotubes (CNT) ? Explain their types. Write any *two* applications of CNTs. 5

(b) What is organic electronics ? Explain the working of organic diode with the help of a suitable diagram. 5

Physical constants :

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

$h = 6.62 \times 10^{-34}$ J-s

$N_A = 6.023 \times 10^{26}$ $kmol^{-1}$

$R = 8.3$ JK^{-1} mol^{-1}

$e = 1.6 \times 10^{-19}$ C

$\in_0 = 8.85 \times 10^{-12}$ C^2 kg^{-1} m^{-3} s^2

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

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