No. of Printed Pages : 4 **RPHE–004**

Ph. D. IN PHYSICS (PHDPH)

Term-End Examination

December, 2025

RPHE-004 : MATERIALS SCIENCE

Time : 2 Hours *Maximum Marks : 50*

Note : *Attempt any **five** questions. All questions carry equal marks. You can use calculator. Symbols have their usual meanings.*

1. (a) Explain with a diagram, how many identical points are generated by a $\bar{2}$ roto-inversion operation. Between 2-fold rotation and $\bar{2}$ roto-inversion operation, which one has higher order ? Why ?

4+1+2

(b) Distinguish between substitutional and interstitial solid solutions. 3

2. (a) Explain the float zone method of crystal growth with the help of a suitable diagram. State its advantages over Czochralski (CZ) method. 4+1

   (b) What is epitaxial growth ? Explain the set up used for MBE growth technique. 1+4

3. (a) With the help of an appropriate diagram explain the different types of point defects in crystals. 5

   (b) Explain the importance of powder metallurgy. 5

4. (a) Describe the difference between chemical vapour deposition and physical vapour deposition. 5

   (b) If the F centre absorption energy of KCL is 2.2 eV, what is its characteristic absorption wavelength ? 5

5. (a) What are eutectic diagrams ? With the help of a schematic diagram for a binary system, explain the significance of eutectic point and liquidus, solidus and solvus curves. 1+4

   (b) Define corrosion in case of materials. Discuss *four* major factors promoting corrosion process. 5

6. (a) What are shape memory materials ? Explain the hysteresis in phase transition observed in case of NiTi alloy acting as a shape memory material. 2+3

   (b) Explain the phenomena of colossal magnetoresistance (CMR) and giant magnetoresistance (GMR). 5

7. (a) What are fullerenes ? Describe their any *two* applications. 3+2

   (b) What is organic electronics ? Explain the working of organic diode. 1+4

8. (a) What are CERMET materials ? What are their advantages ? What are their applications ? 2+2+1

(b) Explain the Avrami and Johnson-Metil models of computing phase transformation rates based on their assumptions and growth mechanisms. 5

List of Physical Constants :

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

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

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

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

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

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

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