

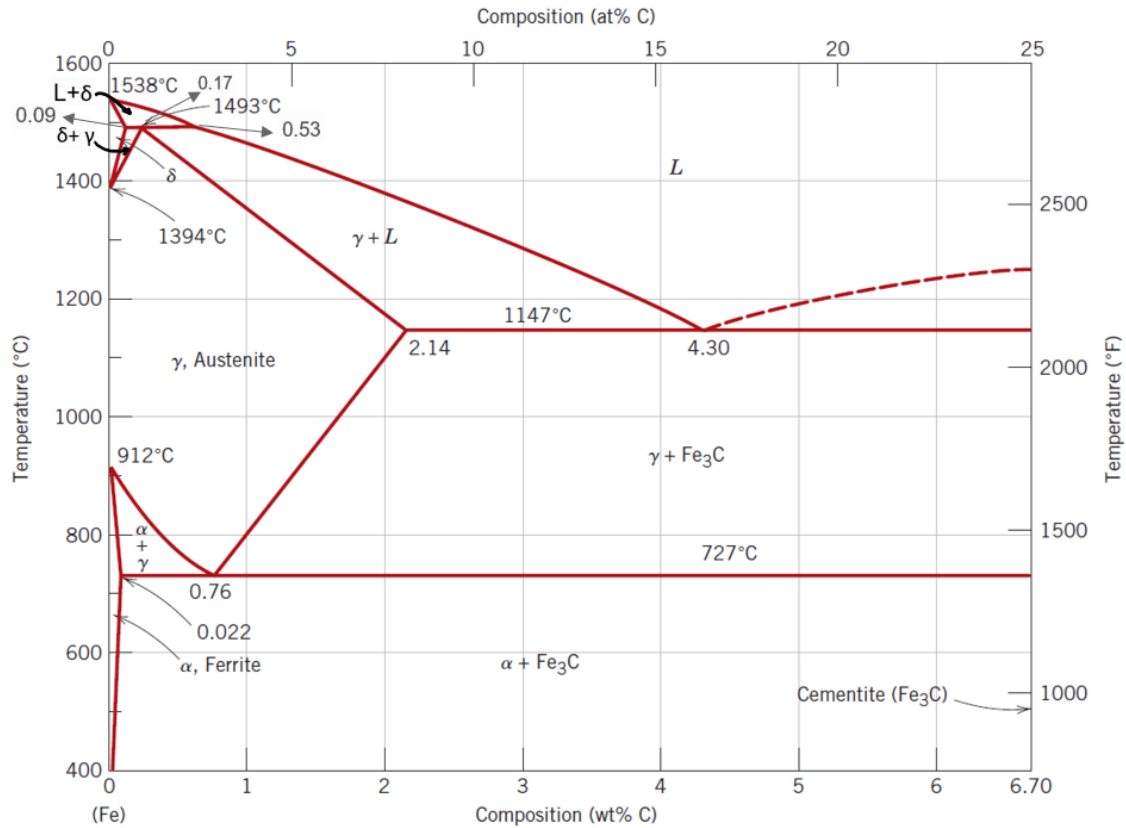
ST. JOSEPH'S COLLEGE (AUTONOMOUS), BENGALURU -27**M.Sc. Physics – IV SEMESTER****SEMESTER EXAMINATION: April 2023****PHDE0520– Material Science (Elective)****Time: 2 ½ Hours****Max Marks: 70****This paper contains TWO printed pages and TWO parts****PART-A****Answer any FIVE questions. Each question carries TEN Marks.****[5 x 10 = 50]**

1. Draw the phase diagram of Copper-Silver and explain the phase transformations as a function of temperature. Mark the eutectic point and explain the eutectic reaction. [10]
2. (a) Explain how Hall coefficient and mobility of a magnetic sample is determined using Vander-Pauw method and derive expressions for the same.
(b) Explain what is Seebeck effect and give one application of this effect. [6+4]
3. (a) With a neat diagram, explain the working of CIGS solar cells.
(b) Explain the substrate and superstrate configurations of solar cells used in thin film technologies and the advantage of superstrate configuration over the other. [7+3]
4. (a) With diagram, explain the working of Fuel Cells.
(b) With a neat sketch, explain the optical band gap of bulk and nano structures? How do the optical properties of nanostructures change as their size is reduced? [5+5]
5. (a) Describe the processes of absorption, fluorescence, phosphorescence, internal conversion, intersystem crossing, and vibrational relaxation using a Jablonski diagram?
(b) Using double heterostructure, explain the working principle of light emitting diode. [6+4]
6. (a) With a neat sketch, explain the RKKY interaction.
(b) Obtain an expression for Giant Magneto Resistance (GMR) with a suitable diagram. [3+7]
7. With a neat sketch, describe the essential components, construction and working principle of Molecular Beam epitaxy. [10]

PART - B**Answer any FOUR questions. Each question carries FIVE Marks.****[4 x 5 = 20]**

8. Compare the performance characteristics of Lead-acid batteries, Lithium-ion batteries and supercapacitors.
9. A 9V battery is in series with a 680 Ω resistor and a Green LED with a forward voltage drop of 2V. Calculate the power dissipated by the LED.

10. Compare the superlattice structure and Quantum well structure with a suitable diagram.
11. Calculate the composition and relative mass fraction of the phases present at the i) Eutectic and ii) Peritectic compositions (points) in the given Iron-Iron Carbide phase diagram.



12. Calculate the undercooling that is required for liquid to crystal transformation in tin. The enthalpy of fusion for tin is 0.42 GJ m⁻³. Appreciable nucleation occurs when the free energy of the critical nucleus is 1.5x10⁻¹⁹ J. The liquid-crystal interfacial energy is 0.055 J m⁻². The melting temperature of Tin is 232°C. Given that the total free energy change in a solidification transformation is given as:

$$\Delta G = \frac{4}{3}\pi r^3 \Delta G_v + 4\pi r^2 \gamma$$

Here, ΔG_v is the free energy per unit volume given as $\Delta G_v = \frac{\Delta H_f(T_m - T)}{T_m}$ and γ is the surface energy per unit area.

13. Find the reflectivity and acceptance angle of cone in semiconductor – air interface.

