

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER– IV(NEW) EXAMINATION – SUMMER 2023

Subject Code:3142111**Date:19-07-2023****Subject Name: Phase Transformations****Time:10:30 AM TO 01:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

		MARKS
Q.1	(a) Thermodynamically, what is the phase?	03
	(b) Describe the type of phase transformations.	04
	(c) What is the Fick's law of diffusion? Explain the Fick's first law. How it is differ with the Fick's second law?	07
Q.2	(a) Illustrate vacancy diffusion mechanism.	03
	(b) What is the diffusion? Why does diffusion occur in metals and alloys?	04
	(c) Explain the applicable law for the non-steady-state diffusion. What is the application of this law in industrial application?	07
OR		
	(c) Elaborate on grain growth phenomena. Describe the total rate of transformation in terms of the rate of nucleation and rate of growth.	07
Q.3	(a) Define the terms Gibbs free energy, entropy, and enthalpy.	03
	(b) Name two reasons why interstitial diffusion is typically faster than vacancy diffusion.	04
	(c) Investigating β nucleation from α on the planar surface of foreign inclusion δ . Derive the relationship between heterogeneous and homogeneous nucleation under Case I- the product particle only makes point contact with the foreign surface $\theta = 180^\circ$, Case II- if the product particle completely wets the foreign particle surface $\theta = 0^\circ$, and Case III- if the product particle is hemisphere in shape $\theta = 90^\circ$.	07
OR		
Q.3	(a) List the sequence of preferential sites where the rate of heterogeneous nucleation increasing by decreasing ΔG^* .	03
	(b) Discuss the factors that control the rate of diffusion.	04
	(c) Outline the interface and explain in depth the characteristics of the low angle grain boundary.	07
Q.4	(a) What are the full form of LRO and SRO? What is it signifies in phase transformation?	03
	(b) What are the possible diffusional phase transformations in solids? Explain to anyone.	04
	(c) Determine the formula to find the critical free energy and particle radius of homogeneous nucleation.	07
OR		
Q.4	(a) Which type of effects can be observed when materials are underage, and peak aged?	03

- (b) Describe the distinctions between coherent, semi-coherent and incoherent interfaces in regards to solid-state phase transformations. **04**
- (c) Present and elaborate the mechanism of interstitial and substitutional diffusion process with a schematic presentation. **07**
- Q.5** (a) Derive an expression for the growth kinetics. **03**
- (b) How does interfacial energy (γ) correlate with misorientation (θ)? What is the θ value for boundaries of both low and high angle? **04**
- (c) Consider the gas carburizing of gear of 1020 steel at 927 °C. Calculate the time in minute to increase the C content of 0.4 % at 0.5 mm below the surface. Assume that the C content at the surface is 0.9 % and that the steel has a nominal C content of 0.2 %. Given that D at 927 °C is $1.28 \times 10^{-11} \text{ m}^2/\text{s}$, $z = 69.68/\sqrt{t}$ then $\text{erf}z = 0.7143$. **07**
- OR**
- Q.5** (a) Describe the Kirkendall Effect through a schematic experimental arrangement. **03**
- (b) With the help of example, describe the age hardening phenomena. **04**
- (c) With the help of the free energy-composition diagram, explain the mechanism of spinodal decomposition. **07**
