

**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-IV (NEW) EXAMINATION – WINTER 2023****Subject Code:3142111****Date:24-01-2024****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.

|            |                                                                                                                                                                                                  | <b>Marks</b> |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Q.1</b> | (a) Define diffusion and state Flick's first and second laws of diffusion.                                                                                                                       | <b>03</b>    |
|            | (b) Explain the difference between homogeneous and heterogeneous nucleation.                                                                                                                     | <b>04</b>    |
|            | (c) Discuss the importance of controlling nucleation and grain growth in the production of high-quality metals and alloys.                                                                       | <b>07</b>    |
| <b>Q.2</b> | (a) Explain the concept of critical nuclei size and its role in nucleation.                                                                                                                      | <b>03</b>    |
|            | (b) Define the terms with necessary schematics- Crystal, Crystal structure, Grains, Grain boundary, Phase & phase transformation.                                                                | <b>04</b>    |
|            | (c) Discuss about Kirkendal's experiment and outcome of it .                                                                                                                                     | <b>07</b>    |
|            | <b>OR</b>                                                                                                                                                                                        |              |
|            | (c) Define the following phases in Fe-C System,<br>1. Delta ferrite 2. Alpha ferrite 3. Austenite, 4. Bainite 5. Pearlite 6. Cementite 7. Martensite                                             | <b>07</b>    |
| <b>Q.3</b> | (a) State the peritectic, Eutectic & eutectoid reactions with reference to Fe-Fe <sub>3</sub> C diagram with examples.                                                                           | <b>03</b>    |
|            | (b) With reference to Fe-Fe <sub>3</sub> C Phase diagram, draw and explain the austenite to pearlite transformation process for 0.8% C steel                                                     | <b>04</b>    |
|            | (c) Draw label 96%wt.Al- 4%wt. Cu phase diagram and explain solution-precipitation treatment with schematics.                                                                                    | <b>07</b>    |
|            | <b>OR</b>                                                                                                                                                                                        |              |
| <b>Q.3</b> | (a) State suitable examples of diffusion transformation and diffusion less transformation in ferrous alloys system.                                                                              | <b>03</b>    |
|            | (b) Explain the Vacancy diffusion and Interstitial diffusion mechanisms giving suitable example of binary alloys.                                                                                | <b>04</b>    |
|            | (c) Discuss the factors that affect the formation of martensite in steels, including cooling rate and carbon content.                                                                            | <b>07</b>    |
| <b>Q.4</b> | (a) Describe the microstructure of martensite and its mechanical properties.                                                                                                                     | <b>03</b>    |
|            | (b) Explain the difference between pro-eutectoid and eutectoid steel and how they differ in terms of the formation of pearlite.                                                                  | <b>04</b>    |
|            | (c) Draw TTT & CCT diagram for eutectoid steel label it properly and state the application of this diagram.                                                                                      | <b>07</b>    |
|            | <b>OR</b>                                                                                                                                                                                        |              |
| <b>Q.4</b> | (a) Does original austenite grain size has any effect on transformation products-ferrite Pearlite or Martensite?                                                                                 | <b>03</b>    |
|            | (b) Why it is necessary to hold the metal at above Ac <sub>1</sub> and/or A <sub>cm</sub> temperature for hypoeutectic and hypereutectic steels respectively once austenite has started forming? | <b>04</b>    |

- (c) How does the formation of martensite affect the toughness and ductility of steels? Which heat treatment do you suggest for as-quench martensite? and Why? **07**
- Q.5** (a) Does spinodal decomposition microstructure increases hardness & strength of the Fe-Cu, Fe-Cr and Fe-Ni-C metallic alloys? How? **03**
- (b) Why martensitic transformation is called as diffusion-less transformation. **04**
- (c) How does cooling rate affect solid-state phase transformations in materials? Provide some examples **07**
- OR**
- Q.5** (a) Explain the difference between upper bainite and lower bainite in terms of their microstructures. **03**
- (b) Explain the difference between long-range and short-range order in materials, and how this relates to the order-disorder transformation. **04**
- (c) What is the effect of retained austenite in as-quench martensitic structure? how it can be reduced? Explain with example. **07**

\*\*\*\*\*