Registration No.: | | | | | | | | | | |

Total Number of Pages: 02

Course: B.Tech/IDD
Sub_Code: MFPC2002

3rd Semester Regular Examination: 2024-25
SUBJECT: INTRODUCTION TO PHYSICAL METALLURGY AND ENGINEERING MATERIALS
BRANCH(S): AUTO, MANUTECH, MECH, ME, MMEAM
Time: 3 Hours
Max Marks: 100
Q.Code: R615

Answer Question No.1 (Part-I) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 **Answer the following questions:** **(2 x 10)**

- **a)** Define amorphous materials.
- **b)** What do you mean by slip and twin?
- **c)** Define substitutional solid solution.
- **d)** Define Gibbs Phase rule.
- **e)** What is normalizing?
- **f)** What is cold working?
- **g)** What do the terms liquidus line and solidus line represent in a binary phase diagram?
- **h)** What is the carbon content range in cast iron?
- **i)** How is the hardenability of a material defined?
- **j)** What is annealing, and why is it performed on metals?

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

- **a)** Classify engineering materials based on their structure and properties. Explain each category with examples and typical applications.
- **b)** Classify crystal defects into point defects, line defects, and surface defects. Explain each type briefly with examples of how they affect the properties of materials.
- **c)** Explain the key phase transformations in the iron-carbon system, including the eutectoid reaction. Describe the formation of phases like ferrite, austenite, and cementite during cooling.
- **d)** Explain the effect of annealing on the microstructure of metals.
- **e)** State and explain the Hume-Rothery rules for the formation of substitutional solid solutions.
- **f)** Explain the eutectic system in phase diagrams. Describe the eutectic reaction and illustrate with an example, mentioning key points such as eutectic composition, eutectic temperature, and the phases involved.

g) What is heat treatment? List and briefly explain three common heat treatment processes.

h) Explain the significance of the Time-Temperature-Transformation (TTT) diagram in heat treatment of steels. Describe the major phases formed during cooling and the importance of critical cooling rates.

i) What is annealing? Explain the different types of annealing processes and their purposes in improving the properties of metals.

j) Draw a labeled iron-carbon phase diagram and explain the key phases and critical temperatures. Briefly describe the eutectoid reaction and the formation of pearlite.

k) What is hardening of steels? Explain the mechanisms involved in the hardening process and the microstructural changes that occur during quenching.

l) Explain the concept of a binary phase diagram. Describe the significance of the liquidus line, solidus line, and solvus line with the help of a simple binary phase diagram sketch.

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 Classify steels into different types based on their carbon content (low, medium, high carbon steels) and alloying elements (alloy steels, stainless steels, tool steels). Explain the properties and typical applications of each type with suitable examples. **(16)**

Q4 Describe the heat treatment processes of annealing, normalizing, hardening, and tempering in steel. Explain their effects on microstructure and mechanical properties. **(16)**

Q5 Describe the construction and interpretation of a Continuous Cooling Transformation (CCT) diagram. Explain its role in predicting microstructural changes during different cooling rates in steels. Compare it with the TTT diagram and provide examples of applications in heat treatment processes. **(16)**

Q6 Define alloy steels and explain their classification. Discuss the effects of common alloying elements such as chromium, nickel, molybdenum, and vanadium on the properties of steel, with examples of their applications. **(16)**