

5

Program: B.Sc. Engg. (IPE)/2nd Sem

10:00 am – 12:00 pm, (Wednesday), 10 Sep. 2025

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination

Course No.: ME 4225

Course Title: Material Engineering

Summer Semester, A. Y. 2023-2024

Time: 2 Hours

Full Marks: 120

There are 4 (Four) questions. Answer all the questions.

Marks for each question and the corresponding CO, PO, and K/P/A are written in brackets.

Do not write on this question paper.

-
- Q1. Suppose you work as a material specialist in a steel manufacturing company and your role is to ensure best quality steel production. Based on your experience as a material specialist answer the following questions: [10+20]
CO2, PO2
K3, P1
- a) Explain the difference between a Phase Diagram and a TTT (Time-Temperature-Transformation) Diagram. Explain the process of nucleation and crystal growth during solidification of a liquid phase.
- b) Quenching is one of the most important heat treatment processes for steels.
- Define quenching and explain why it is used in steels.
 - Discuss how the choice of quenching medium affects the cooling rate and final microstructure of steel. Show the microstructure as well
 - Explain the three stages of heat removal during quenching with the help of a cooling curve diagram and mechanism.
 - Discuss one practical advantage and one disadvantage of quenching in steel components.
- Q2. a) Draw a well-labeled Iron-Iron Carbide (Fe-Fe₃C) phase diagram. Clearly indicate all critical points and phase boundaries, including the following [15+15]
CO2, PO2
K4, P3
- b) A steel alloy with 0.4% carbon by weight is cooled slowly from 900°C to 700°C. Using the Fe-Fe₃C phase diagram:
- Determine the phases present at 800°C.
 - Calculate the weight fractions of each phase at 800°C using the lever rule
- Q3. As a materials engineer, your responsibility is not only to optimize performance and cost but also to ensure that your material choices support long-term environmental and societal goals. [20]
CO3, PO3
K7, P3
- What is sustainability in the context of engineering materials? Why is it important in modern product design?
 - With reference to the Total Materials Cycle, discuss briefly how each stage from raw material extraction to end-of-life—affects sustainability decisions.
 - What is an Ashby Chart? How can it be used to make informed material selection decisions when considering performance, cost, and environmental impact?

Q4. a) With the help of neat sketches, depict and label the different phases present at room temperature in:

**[10+8+12+
10]
CO4, PO4
K4, P1**

1. Hypoeutectoid steel
2. Eutectoid steel
3. Hypereutectoid steel

b) Define heat treatment and explain its general purpose in engineering materials.

c) Define surface hardening and give example of application of this process. Briefly explain how carburising, nitriding, and cyaniding modify the surface layer to improve hardness and wear resistance.

d) What is the Jominy End Quench Test, and how is it conducted? Briefly explain the procedure and purpose.