VIT
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SLOT: B1+TB1

REG.NO.:

SCHOOL OF MECHANICAL ENGINEERING
CONTINUOUS ASSESSMENT TEST (CAT) -II
FALL SEMESTER 2024-2025

Programme Name & Branch	:	B.Tech. Mechanical Engineering
Course Code	:	BMEE209L
Course Name	:	Materials Science and Engineering
Faculty Name(s)	:	Dr. Chinmaya Prasad Mohanty, Dr. Devasri Fuloria, Dr. Geetha Manivasagam, Dr. Kishore Kumar Mahato, Dr. Devendranath Ramkumar
Class Number(s)	:	VL2024250103832, VL2024250103833, VL2024250103834, VL2024250103835, VL2024250103836
Exam Duration	:	90 minutes **Max. Marks** : 50

Answer **all**

General instruction(s):

- M - Max mark; CO – Course Outcome; BL – Bloom's Taxonomy Level(1-Remember, 2-Understand, 3-Apply, 4-Analyse, 5-Evaluate, 6-Create)
- Course Outcomes

CO2	Examine various phases of metals and alloys using phase diagrams
CO4	Recommend suitable heat treatment and surface hardening processes.

Q. No	Question	M	CO	BL
1.	Discuss the phase diagram of Al_2O_3-Cr_2O_3 based on the diagram below [Fig. 1].	10	CO2	BL3

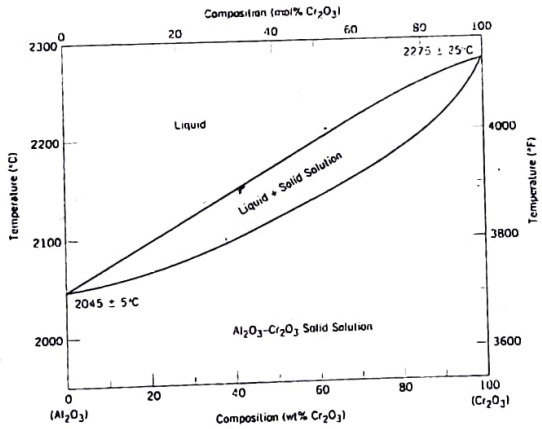

Fig.1 Al_2O_3-Cr_2O_3 phase diagram

Now, consider that you start to heat a solution of 60 wt% of Cr_2O_3 from room temperature up to 2200°C

(a)What is the melting temperature of pure Al_2O_3 and pure Cr_2O_3?
(b) What is the solubility of Cr_2O_3 in Al_2O_3?
(b) At which temperature the first liquid appears?
(c) What is the weight percentage of Cr_2O_3 in the first liquid phase formed?
(d) At which temperature is all the solution transformed to liquid?
(e) What is the composition of the last solid just before melting?
(f) What is the amount of liquid and solid phases at around 2150°C?

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2.	Draw and discuss the phase diagram involving two metallic elements which have restricted solid solubility in each other and form terminal solid solutions and the alloy is used for soldering, with a suitable example. Explain the significance of the various lines appearing in the phase diagram.	10	CO2	BL2
3.	a) What is the solubility of Carbon in δ, γ and α-phases of Fe? (02) b) Identify the crystal structure of (i) Cementite (ii) Austenite and (iii) Martensite and write the lattice parameters (02) c) Why the solubility of carbon in austenite is higher than that in ferrite? Reason out. (04) d) What is the limitation of the phase diagram? (02)	10	CO2	BL2
4.	Using the isothermal transformation diagram for an Iron-Cementite alloy of eutectoid composition, specify the nature of the final microstructure (in terms of micro-constituents present and approximate percentages of each) of a small specimen that has been subjected to the following time-temperature treatments. In each case, assume that the specimen begins at 760 °C and that it has been held at this temperature long enough to have achieved a complete and homogeneous austenitic structure. i. Cool rapidly to 350 °C, hold for 10^3 s, then quench to room temperature. ii. Rapidly cool to 625 °C, hold for 10 s, then quench to room temperature. iii. Rapidly cool to 600°C, hold for 4 s, rapidly cool to 450°C, hold for 10 s, then quench to room temperature. iv. Reheat the specimen in part (iii) to 700 °C for 20 h. v. Rapidly cool to 300 °C, hold for 20 s, then quench to room temperature in water. Reheat to 425 °C for 10^3 s and slowly cool to room temperature. vi. Cool rapidly to 665 °C, hold for 10^3 s, then quench to room temperature. vii. Rapidly cool to 575 °C, hold for 20 s, rapidly cool to 350 °C, hold for 100 s, then quench to room temperature. viii. Rapidly cool to 350 °C, hold for 150 s, then quench to room temperature. Sketch and label time-temperature paths on this diagram to produce the following microstructures - 50% coarse pearlite, 25% bainite, and 25% martensite.	10	CO4	BL4
5.	Justify and reason out the following statements: a) Explain why thicker sections are more susceptible to cracking during hardening heat treatment. (03) b) If eutectoid steel is kept at 700^0C for a prolonged time, what change do you expect? (02) c) Bring out the differences between Athermal and isothermal transformation. Using one of the heat treatments in each to understand these transformations in detail with suitable reaction diagrams and reaction products. (05)	10	CO4	BL4

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