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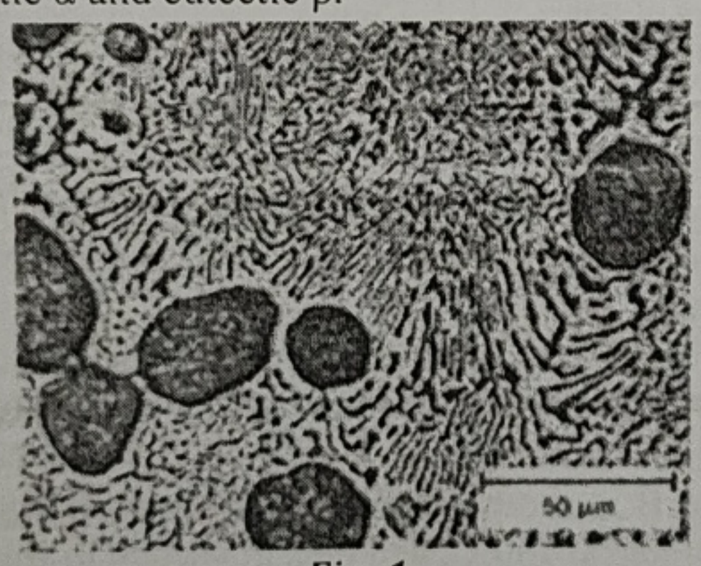
SCHOOL OF MECHANICAL ENGINEERING
CONTINUOUS ASSESSMENT TEST – II
FALL SEMESTER 2023-2024

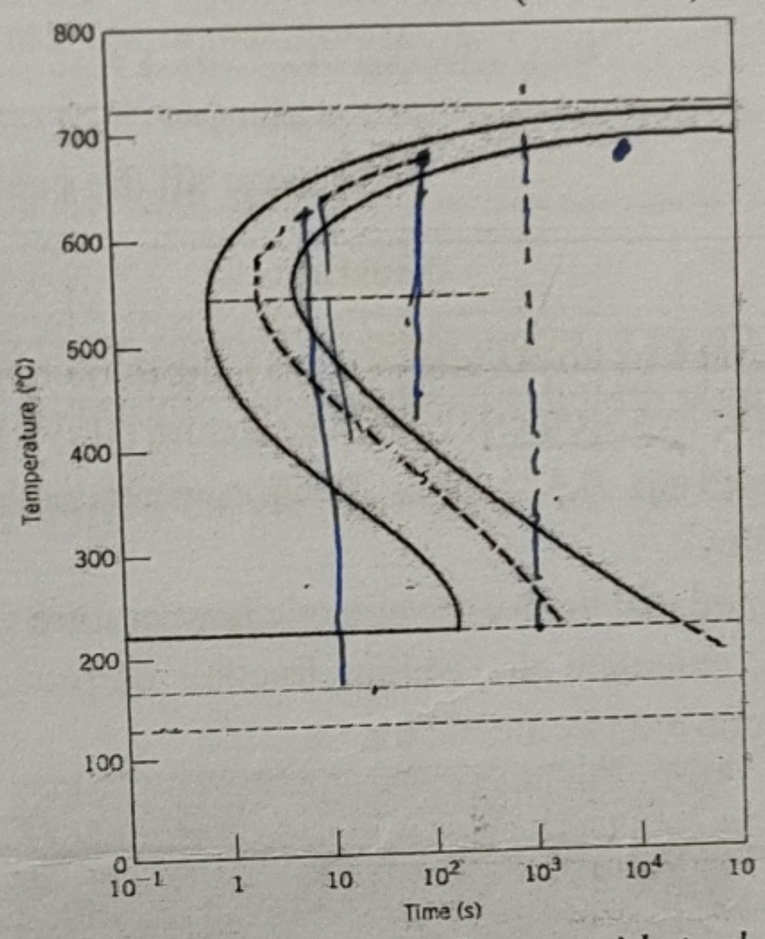
SLOT: B2+TB2

Programme Name & Branch : B.Tech. Mechanical Engineering
Course Code : BMEE209L
Course Name : Materials Science and Engineering
Faculty Name(s) : Dr. Ariful Rahaman, Dr. Padmanabhan K, Dr. Sreekanth M.S., Dr. Sitaram Das, Dr. Arivazhagan N.
Class Number(s) : VL2023240101870, VL2023240101663, VL2023240101665, VL2023240101869, VL2023240101661

Exam Duration: 90 minutes **Maximum Marks: 50**

General instruction(s): Answer **all** the questions.

Q. No.	Question	Marks
1	Following is a micrograph of Pb-Sn alloy (Fig. 1), the darker phase is β and the lighter one is α. Is it a eutectic, hypoeutectic or hypereutectic alloy? If the microstructure of the alloy is composed of 0.5 weight fraction proeutectic phase, what is the composition of the alloy? The same alloy is cooled just below the eutectic temperature (183°C). Just below the eutectic temperature, calculate the weight fraction of proeutectic phase, eutectic mixture (α + β), eutectic α and eutectic β.  *Fig. 1*	10
2.	(a) FCC is a more close packed structure yet solubility of carbon in austenite which is FCC is higher than that in ferrite which is BCC. Why it is so? **(4 marks)** (b) Draw microstructure of (i) hypo-eutectoid (0.4% C), (ii) eutectoid and (iii) hyper-eutectoid (1 % C) steel at room temperature. **(6 marks)**	10
3.	(a) Using the T-T-T diagram (Fig. 2) for eutectoid steel, draw the specified cooling path on the diagram. Indicate what phases you expect in the final product. Assume the material has been fully austenitized before cooling. ***i) Rapidly cool to 550°C, soak for 2 hours, then quench to room temperature.*** ***ii) Rapidly cool to 500°C, soak for 10 seconds, then quench to room temperature.*** ***iii) Rapidly cool to 300°C, soak for 15 minutes, then quench to room temperature.*** ***iv) Rapidly cool to 600°C, hold for 7 s, then quench to room temperature*** ***v) Rapidly cool to 665°C, hold for 10^3 s, then quench to room temperature.*** **(5 marks)** (b) TATA steel producer has five "quench baths," used to quench plates of eutectoid steel to 680°C, 570°C, 550°C, 380°C, and 28°C respectively. Using the TTT diagram below, advise the company on how they can produce steel with the following	10

	microstructures. Assume that each bath will instantaneously allow the steel to reach the bath temperature. ***i) 25% fine pearlite, 25% lower bainite, 50 % coarse pearlite.*** ***ii) 50% coarse pearlite, 50% martensite.*** ***iii) 50% upper bainite, 50% fine pearlite*** ***iv) 100 % Martensite*** ***v) 100 % Cementite*** **(5 marks)**  ***Fig. 2 TTT diagram of eutectoid steel.***	
4.	Suppose three hyper eutectoid steel samples (**A, B, and C**) of 1 wt% carbon are each equilibrated at 1000°C. (i) Draw a well labelled sketch of the microstructure of these samples (at 1000°C). (ii) Suppose sample **A** is quenched in water from 1000°C to room temperature. Draw a well labelled sketch of microstructure of sample A after quenching. (iii) Suppose sample **B** is cooled from 1000°C to 730°C (just above the eutectoid temperature), equilibrated at 730°C, and then quenched in water from 730°C to room temperature. Draw a well labelled sketch of microstructure of the microstructure of sample B after quenching. (iv) Suppose sample **C** is cooled in air from 1000°C to room temperature. Draw a well labelled sketch of microstructure of the microstructure of sample C after cooling in air. (v) Rank the three samples in terms of their hardness from highest to lowest after each has reached room temperature. Briefly justify this ranking.	10
5.	(a) Explain why austenization temperature for annealing and normalizing differ for hyper eutectoid steel. **(4 marks)** (b) Using TTT diagram of eutectoid steel, differentiate between (i) austempering and (ii) martempering. Briefly describe the advantages of each type of heat treatment. **(6 marks)**	10

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