Name:

Enrolment No:

UPES

End Semester Examination, December 2023

Course: Materials Science | **Semester** : 3rd SEM

Program: Mechanical Engineering/Mechatronics Engineering | **Time** : 03 hrs.

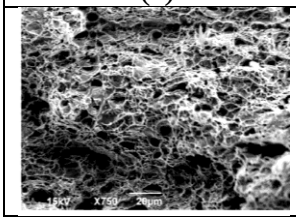
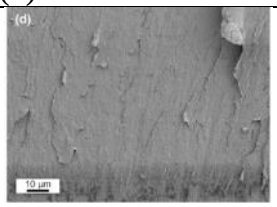
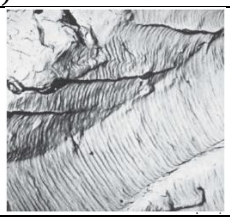
Course Code: MEMA2001 | **Max. Marks : 100**

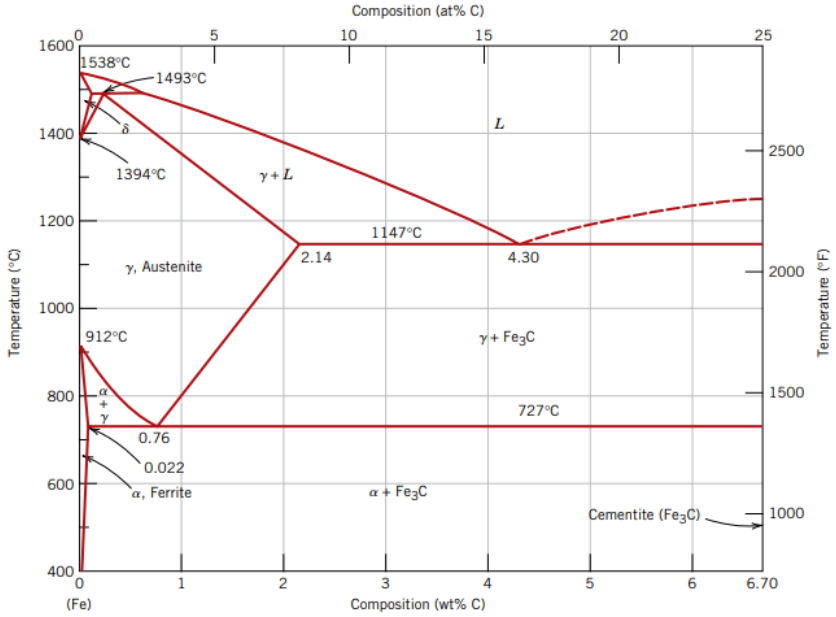
Instructions: Attempt all questions. One question from section C has an internal Choice. Assume any missing data if required.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Define Screw and Edge dislocation with a suitable scheme.	**4**	**CO1**
Q 2	Neatly sketch the various fatigue loading cycles	**4**	**CO1**
Q 3	Draw the scheme of an isomorphous phase diagram of two component system with all the important labels.	**4**	**CO2**
Q4	Distinguish between system, phase, component, and microstructure.	**4**	**CO2**
Q 5	Differentiate in between eutectic, eutectoid and peritectic invariant reactions.	**4**	**CO1**

SECTION B
(4Qx10M= 40 Marks)

Q 6	(a) Write a short note on Liquid Penetrant Testing with a suitable scheme. (b) Discuss 2 types of brittle fractures with a suitable scheme.	**6** **4**	**CO1**
Q 7	(a) Explain Ductile-to-Brittle Transition of a materials. (b) Explain the structure and properties of malleable cast iron	**5** **5**	**CO2**
Q 8	(a) Derive the expression which relates interplanar spacing, Miller indices and dimension of the cubic unit cell. (b) Illustrate the process of measuring toughness values for structural materials.	**5** **5**	**CO3**
Q 9	(a) Analyze the fracture surface and identify their nature of failure. (a)  (b)  (c) 	**4** **6**	**CO4**

	(b) Derive the expression for critical free energy required for the formation of nucleus.		
	SECTION-C **(2Qx20M=40 Marks)**		
Q	(i) Describe annealing, normalizing and quenching processes. (ii) Discuss Cyaniding and nitriding processes. (iii) Under what necessary cooling conditions, martensite forms.	**12** **6** **2**	**CO3**
	A. Analyze the Fe-Fe_3C Phase diagram and answer the following questions: (i) Write the solubility of carbon in ferrite at 727 ℃. (ii) At what temperature solubility in austenite phase is maximum. (iii) Write the name of eutectoid product. (iv) Write eutectoid, eutectic and peritectic temperatures. (v) Write all the invariant reactions in this diagram and mention their phase composition.  B. Sketch and explain the microstructure evolution of hyper-eutectoid steel (1%C) at 910 ℃, 800 ℃, 600 ºC. Or **B.** Construct a phase diagram for the system A-B for the following data: Melting point of A = 1000 ºC Melting point of B = 8000 ºC Eutectic Point = 500 ºC at 40 atomic % B Maximum solubility of A in B at 500 ºC = 10 atomic % Maximum solubility of B in A at 500 ºC = 20 atomic % Limits of solid solution at 300 ºC = 10 atomic % in A,	1 1 1 3 6 8 10	**CO4**

	5 atomic % in B. Label the phase diagram. Calculate fractions of proeutectoid phase and eutectic mixture at the eutectic temperature for the alloy containing 25 atomic % B. **(ii)** Make a T-T-T curve for 0.8 wt% eutectoid steel. Mark the areas of coarse perlite, fine perlite, upper bainite and lower bainite.	10	