**Name:**

**Enrolment No:**

**UPES**

**End Semester Examination, December 2023**

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

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

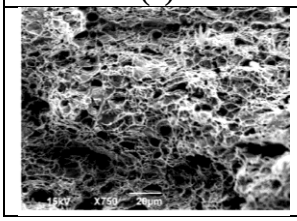
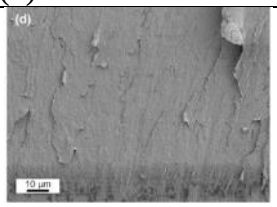
**Course Code:** MEMA2001 — **Max. Marks : 100**

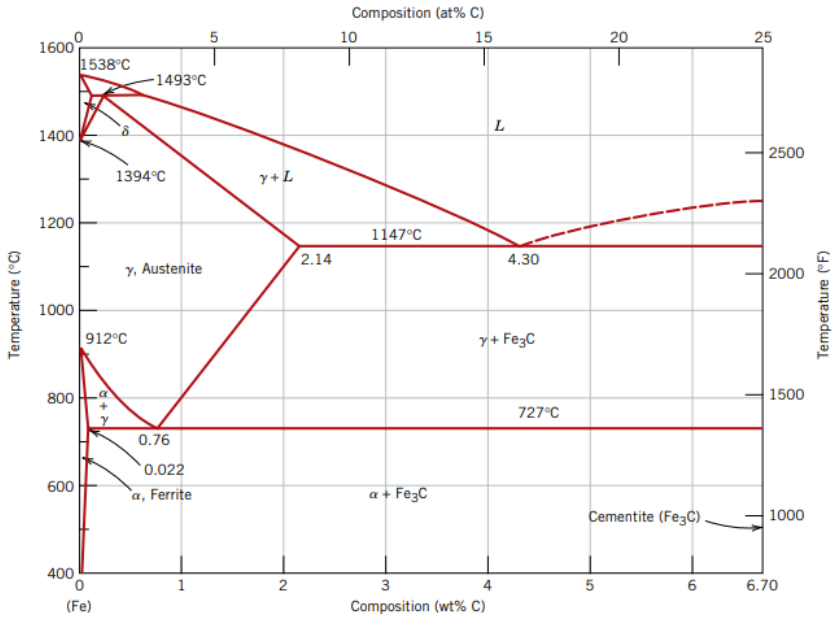
**Instructions:** Attempt all questions. One question from section C has an internal Choice. Assume any missing data if required.

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

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

| | | | |
|---|---|---|---|
| | 5 atomic % in B.<br>Label the phase diagram. Calculate fractions of proeutectoid phase and eutectic mixture at the eutectic temperature for the alloy containing 25 atomic % B.<br>**(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 | |