

Name:  
Enrolment No:



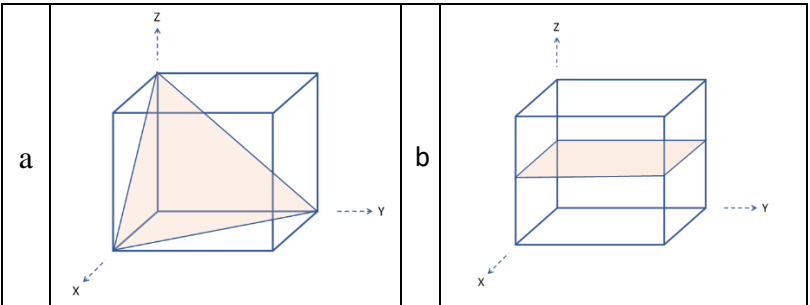
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES  
End Semester Examination, December 2021

Course: Automotive Materials  
Program: B. Tech ADE  
Course Code: MEAD2006

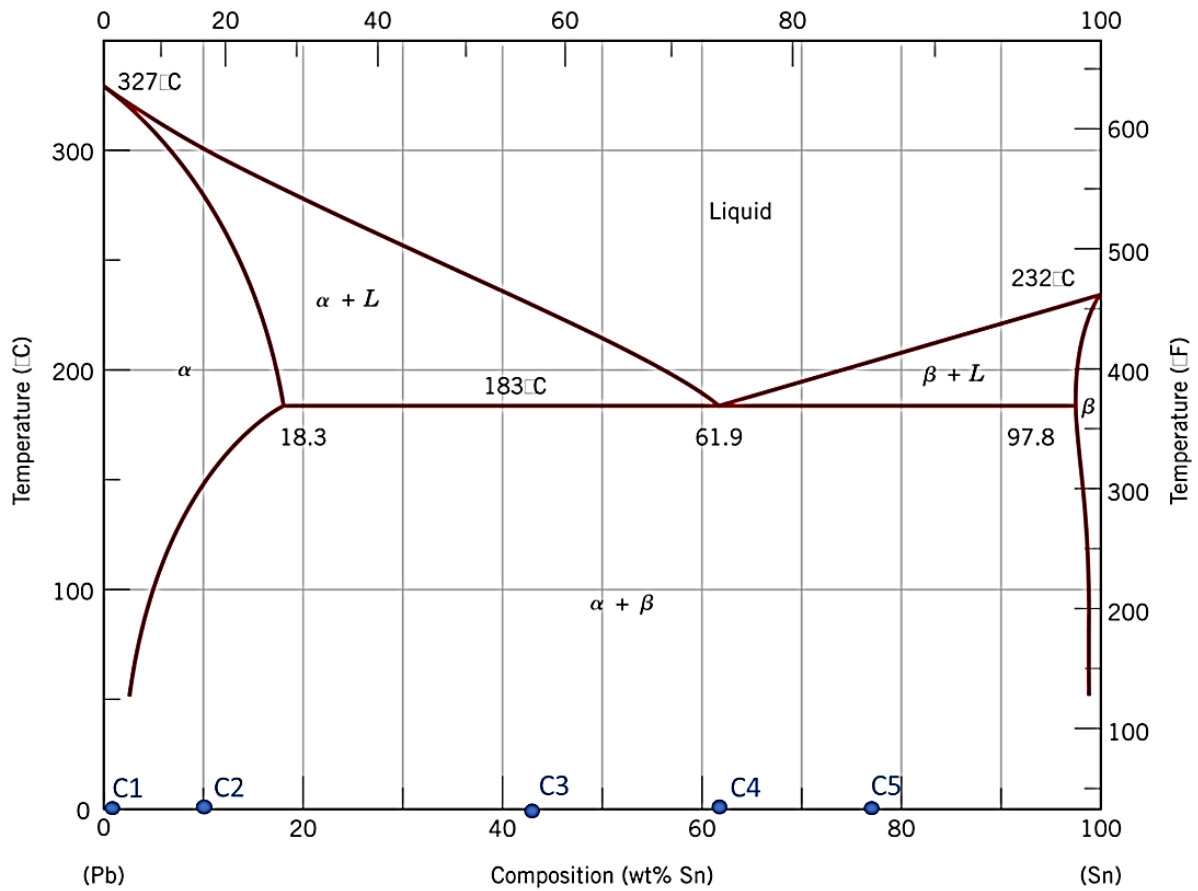
Semester: III  
Time 03 hrs  
Max. Marks: 100

Instructions:

SECTION-A: Total 20 marks  
Each question carries 4 marks

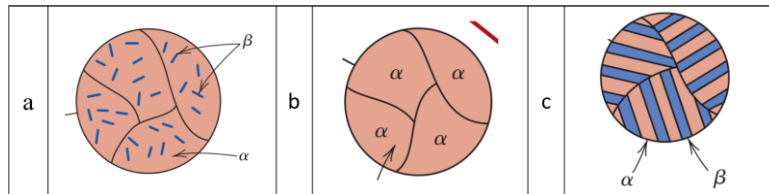
S. No.		CO
Q 1	Classify following materials into their class of materials (metal, alloy, polymer, ceramic, composite): a) Superalloy, b) Teflon, c) Alumina, d) Carbon fibre reinforced polymer  a) _____, b) _____, c) _____, d) _____, e) _____	CO2
Q 2	True/False: a) BCC crystal structure has 3 closest packed planes. _____ b) FCC materials generally have lower strength and are more ductile as compared to BCC materials. _____ c) X-ray diffraction is used to identify the crystal structure of a material. _____ d) Fatigue failure is characterized by formation of beach marks on fracture surface. _____	CO1
Q 3	Identify <b>ALL the correct options</b> related to potential energy curve: a) At equilibrium atomic spacing, overall potential energy is minimum. b) At equilibrium atomic spacing, attractive potential energy is minimum. c) The depth of potential energy well is a measure of cohesive energy. d) At equilibrium atomic spacing, the interatomic force is zero.	CO1
Q 4	Write the miller indices of planes shown in below cubic unit cells:    a) _____, b) _____	CO1

Q 5 Pb-Sn forms a eutectic phase diagram wherein  $\alpha$  is Pb-rich and  $\beta$  is Sn-rich phase.



CO2

Below microstructures can correspond to different compositions: C1, C2, C3, C4 and C5 (marked in above phase diagram). Identify the compositions to which each of the following microstructure belongs:



a) \_\_\_\_\_, b) \_\_\_\_\_, c) \_\_\_\_\_

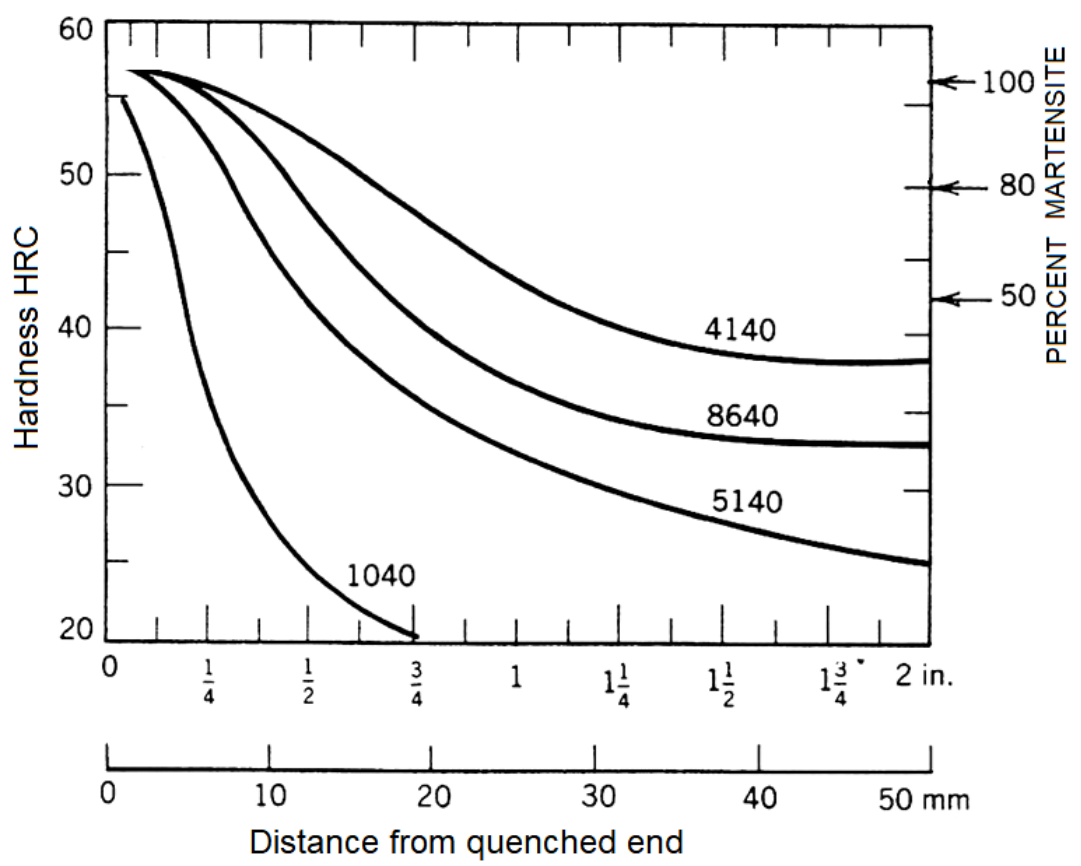
**SECTION-B : Total 40 marks**  
**Each question carries 10 marks**

Q 6 a) List the Hume-Rothery rules which govern solubility in substitutional solid solutions. (5)  
 b) Based on these rules, briefly discuss why Cu-Ni forms isomorphous phase diagram with 100% solid solubility, whereas Pb-Sn form a eutectic phase diagram with considerably lower solid solubility. (5)

CO1

CO2

Q 7 The graph below depicts the Jominy-end quench test results for 5 different grades of steel – 1040, 4140, 5140 and 8640. Using the graph below, measure the hardenability of each steel and arrange them in increasing order of hardenability.



CO3

Q 8 At high temperatures, materials can undergo creep failure. Answer the following related to creep failure:  
 a) Draw a schematic creep curve for a material and clearly mark different regions.  
 b) Arrange the following into increasing order of creep rate and briefly discuss the reasoning:  
 Polycrystalline material, directionally solidified material, single crystal

CO3

Q 9 a) Draw a schematic T-T-T diagram for eutectoid plain carbon steel.  
 Answer **any one of the following**:  
 b) Based on nucleation and growth phase transformation, describe the nose formation in T-T-T diagram.  
 c) Briefly describe the differences between annealing and normalizing heat treatment processes.

CO3

**SECTION-C: Total 40 marks**

Q 10 a) Draw the Fe-C diagram showing eutectoid and eutectic phase transformations. (10)

CO1

Answer **any ONE of the following:**

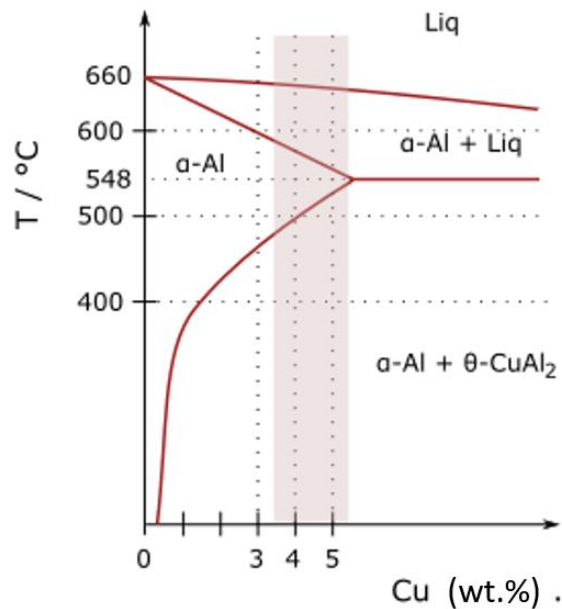
b) Show the microstructural evolution as a **hypo-eutectoid steel** is cooled from single phase austenite region to room temperature. (10)

CO3

c) Show the microstructural evolution as a **hyper-eutectoid steel** is cooled from single phase austenite region to room temperature. (10)

d) Show the microstructural evolution as a **eutectoid steel** is cooled from single phase austenite region to room temperature. (10)

Q 11 Al-based alloys are used extensively in vehicles for various applications. 2000 series corresponds to Al-Cu alloys and the figure below shows the phase-diagram of Al-Cu system.



CO4

**Answer the following:**

- List the two conditions that must be satisfied for any alloy to be precipitation hardened. Based on this, what composition range would be suitable for making a precipitation hardened 2000 series Al-alloy? (6)
- Take any composition from the range identified above and briefly discuss how you would carry out the precipitation hardening heat treatment. (7)
- Discuss how will you optimize the mechanical properties of this alloy by controlling ageing temperature and ageing time. (7)