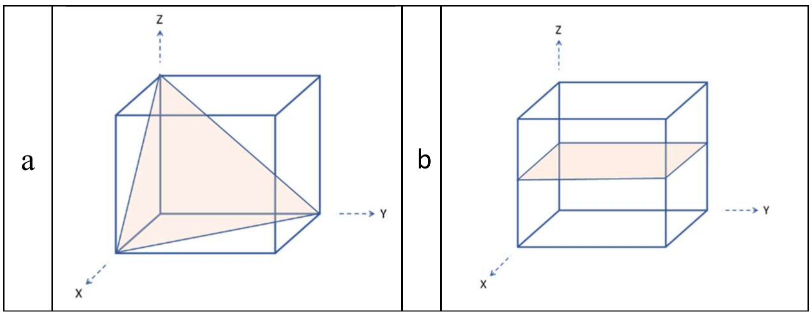
Name: Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Online End Semester Examination, December 2020

Course: Material Engineering **Semester: III**
Program: B. Tech **Time 03 hrs**
Course Code: MEMA2003 **Max. Marks: 100**

Instructions: In Q11 and 12, there is internal choice in the question.

SECTION-A: Total 30 marks
Each question carries 5 marks

S. No.		**CO**
Q 1	Classify following materials into their class of materials (metal/alloy, polymer, ceramic, composite): a) Superalloy, b) Teflon, c) Bronze, d) Alumina, e) 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) Glasses are polycrystalline in nature. _________ e) Fatigue failure is characterized by formation of beach marks on fracture surface. _________	CO1
Q 3	Select **ALL the correct options** 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) The first derivative of potential energy gives the interatomic force between atoms. e) At equilibrium atomic spacing, the interatomic force is zero.	CO1
Q 4	Write the miller indices of planes showed in below cubic unit cells:  a) _______________, b) ______________	CO1

Q 5

Classify following materials into the typing of bonding that exists (ionic/covalent/metallic/ Secondary bonding) :

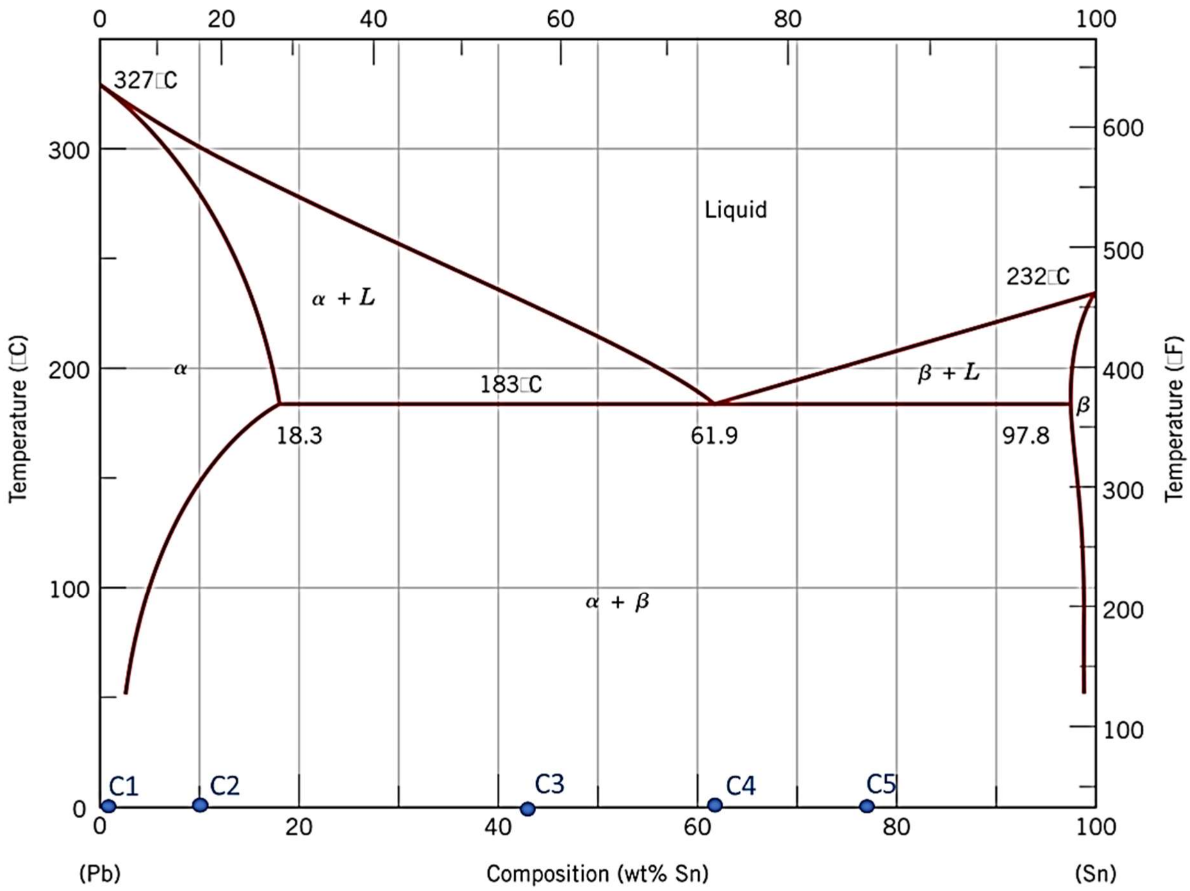
a) NaCl, b) Teflon, c) Bronze, d) Liquid Helium, e) Solder

a) __________, b) ________, c) _________, d) ___________, e) _____________

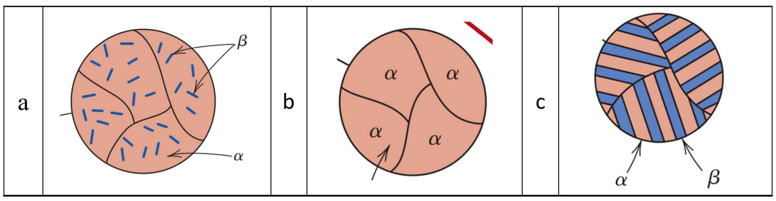
CO1

Q 6

Pb-Sn forms a eutectic phase diagram wherein α is Pb-rich and β is Sn-rich phase.



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:

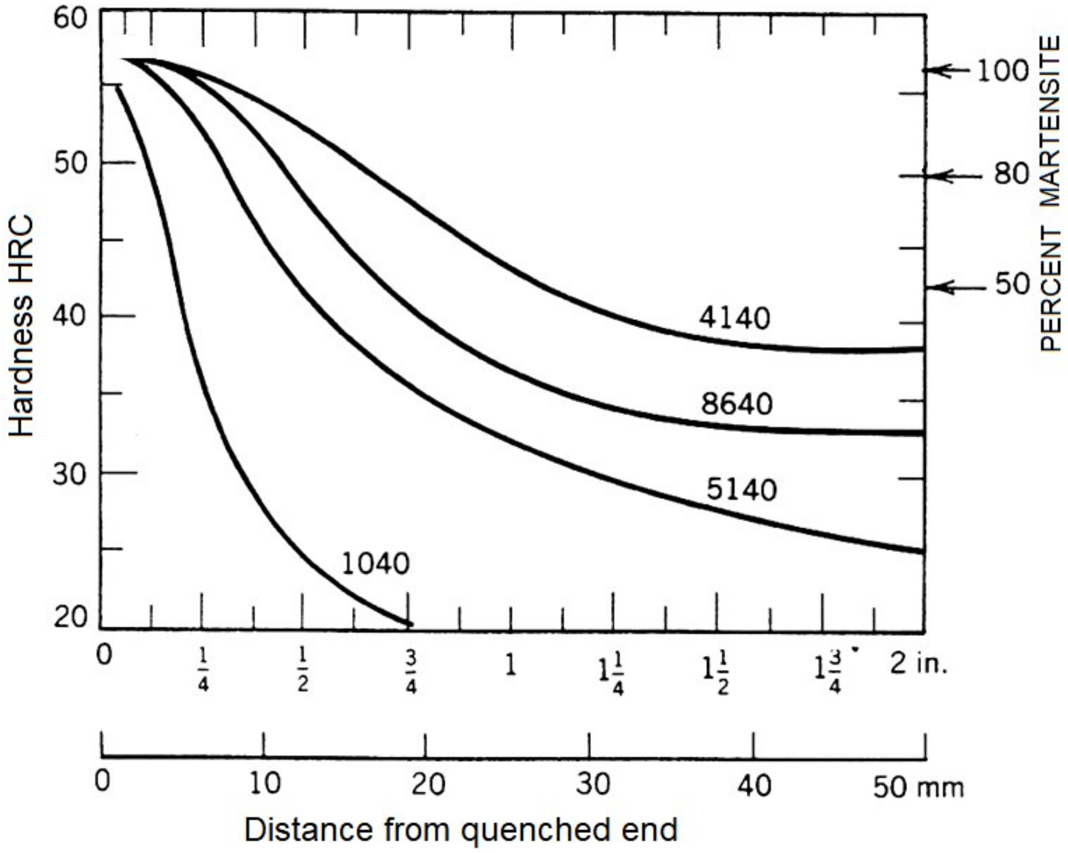


a) ___________, b) ___________, c) ___________

CO1

<table>
<tr><td colspan="3">SECTION-B : Total 50 marks
Each question carries 10 marks</td></tr>
<tr><td>Q 7</td><td>a) List the Hume-Rothery rules which govern solubility in substitutional solid solutions.

b) Based on these rules, briefly discuss why Cu-Ni form isomorphous phase diagram with 100% solid solubility, whereas Pb-Sn form a eutectic phase diagram with considerably lower solid solubility.</td><td>CO1</td></tr>
<tr><td>Q 8</td><td>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.



</td><td>CO2</td></tr>
<tr><td>Q 9</td><td>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</td><td>CO4</td></tr>
<tr><td>Q 10</td><td>For a tensile test done on a material, following information is given:

• At Load, F = 6660 N, Elongation, Δl = 0.50 mm
• Modulus of elasticity, E = 110 GPa
• Yield strength, σ_y = 240 MPa
• Initial gauge length = 380 mm

Find out the initial gauge diameter of the tensile specimen.</td><td>CO2</td></tr>
</table>

Q 11	a) Draw a schematic T-T-T diagram for eutectoid plain carbon steel. Answer **<u>any one of the following</u>**: 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 20 marks		
Q 12	a) Draw the Fe-C diagram showing eutectoid and eutectic phase transformations. Answer **<u>any ONE of the following</u>**: b) Show the microstructural evolution as a **hypo-eutectoid steel** is cooled from single phase austenite region to room temperature. c) Show the microstructural evolution as a **hyper-eutectoid steel** is cooled from single phase austenite region to room temperature. d) Show the microstructural evolution as a **eutectoid steel** is cooled from single phase austenite region to room temperature	CO1 CO5