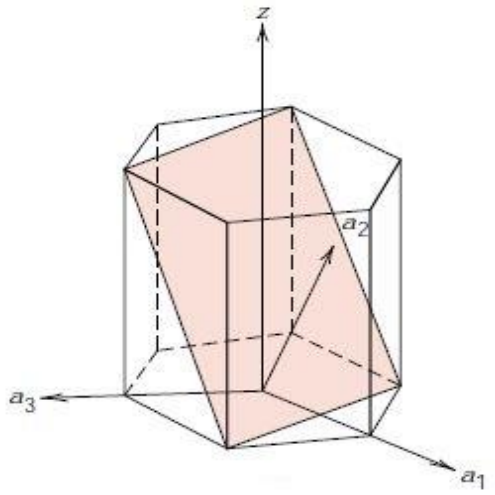
Name: Enrolment No:	UPES

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

Course: Material Science **Semester: IV**
Program: B. Tech. Automotive Design Engineering **Time: 3 Hours**
Course Code: MEMA 2001 **Max. Marks: 100**

SECTION A

1. Attempt all questions. Each question will carry 5 marks.
2. Instruction: For Q-1 to Q-6, Type the final answer only.

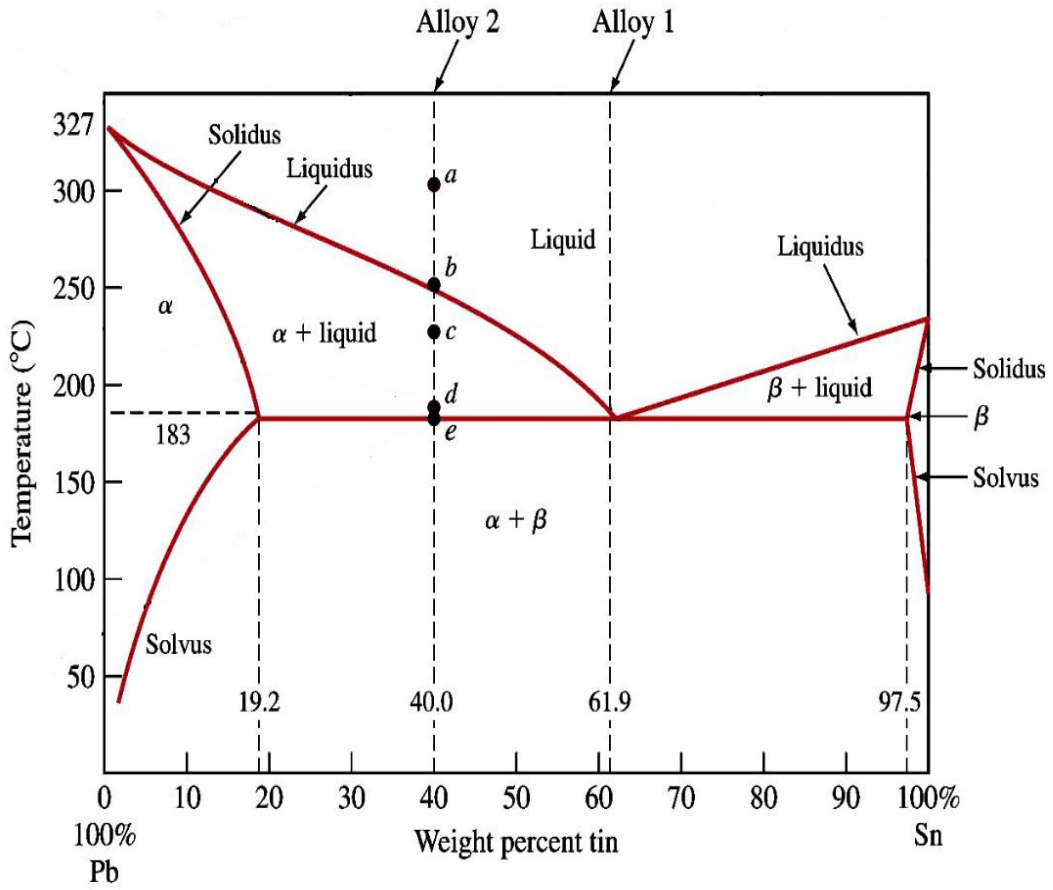
S. No.		Marks	CO
Q-1	Determine the indices of the plane shown in the figure below using three Miller indices system and convert these three Miller indices to four Miller Bravais indices. 	**5**	**CO1**
Q-2	A cubic unit cell has lattice parameter a = 3.69 Å. Determine the inter-planar spacing d_{hkl} of a plane whose normal makes an angle of 65.9° and 35.3° with positive x and z axes respectively where, x, y and z axes are along the edges of this cubic unit cell.	**5**	**CO1**
Q-3	A unidirectional continuous glass-fiber reinforced epoxy resin composite contains 35% volume fraction of E-glass fibers. The modulus of elasticity of glass-fiber and hardened epoxy resin is 72.0 and 4.0 GPa respectively. A piece of this composite having the cross-sectional area 175 mm^2 is subjected to a tensile load of 15 kN. Determine the longitudinal strain developed in the reinforced fibers.	**5**	**CO3**

<table>
<tr><td>Q-4</td><td>What is the chemical formula (can be obtained by converting the atomic % into integers) of an intermetallic compound, which consists of 49.2 wt. % Cu and 50.8 wt. % Au? The atomic weights of Cu and Au are 64 g/mol and 197 g/mol respectively.</td><td>5</td><td>CO1</td></tr>
<tr><td>Q-5</td><td>A relatively large plate of glass is subjected to a tensile stress of 40 MPa. If the specific surface energy and modulus of elasticity for this glass is 0.3 J/m2 and 69 GPa respectively, determine the maximum length of a surface flaw that is possible without fracture.</td><td>5</td><td>CO5</td></tr>
<tr><td>Q-6</td><td>Below are listed the atomic weight, density and atomic radius for two hypothetical alloys. Determine whether the crystal structure of these alloys is FCC, BCC or SC.
<table><tr><th>Alloy</th><th>Atomic Weight (g/mol)</th><th>Density (g/cm^3)</th><th>Atomic Radius (nm)</th></tr><tr><td>A</td><td>184.4</td><td>12.30</td><td>0.146</td></tr><tr><td>B</td><td>91.6</td><td>9.60</td><td>0.137</td></tr></table></td><td>5</td><td>CO1</td></tr>
<tr><td colspan="4">SECTION B
1. Attempt all questions. Each question will carry 10 marks.
2. Instruction: For Q-1 to Q-5, Scan and Upload the answer.</td></tr>
<tr><td>Q-1</td><td>What is a crystal defect? Classify crystal defects based on their geometry and list different types of crystal defects under each classification. Differentiate between Schottky and Frenkel point defects.</td><td>10</td><td>CO1</td></tr>
<tr><td>Q-2</td><td>List the different type of Magnetism occurred in the materials. Narrate the general properties of each type of magnetism.
A wire whose diameter is 0.20 cm must carry a 20A current. The maximum power dissipation along the wire is 4W/m. Calculate the minimum allowable conductivity of the wire in (ohm-meter)$^{-1}$ for this application.</td><td>10</td><td>CO3</td></tr>
<tr><td>Q-3</td><td>Define Creep failure and fatigue failure of metals. What is endurance limit/Fatigue limit for ferrous and nonferrous materials? Discuss various factors affecting creep and fatigue failure.</td><td>10</td><td>CO5</td></tr>
<tr><td>Q-4</td><td>Sketch & explain the T-T-T diagram for eutectoid steel. Depict the important transformations taking place in it during cooling.
OR
What do you understand by case or surface hardening? Write down different methods of case/surface hardening. Explain nitriding process of case/surface hardening.</td><td>10</td><td>CO4</td></tr>
<tr><td>Q-5</td><td>Enumerate advantages and disadvantages of nonferrous alloys. Write down key properties and general applications of aluminium and copper alloys. Discuss the composition and specific applications of the two main alloys of copper.</td><td>10</td><td>CO3</td></tr>
</table>

SECTION C

1. Attempt all questions. Each question will carry 20 marks.

2. Instruction: For Q-1, Scan and Upload the answer.

Q-1	Given below is the phase diagram of Pb-Sn alloy. If one Kg of 70 % Pb- 30 % Sn alloy is cooled from 300 °C, calculate: a. Write coordinates (composition, temperature) of all invariant points and write all the invariant reactions in this diagram. b. Write composition range for hypoeutectic and hypereutectic Pb-Sn alloys. c. The composition and weight percent of liquid phase and proeutectic alpha phase at temperature 250 °C. d. The weight percent and weight in kilograms of proeutectic alpha phase and eutectic product just below the eutectic temperature (183 °C). Thus, calculate the weight percent and weight in kilograms of alpha and beta phases in this alloy just below the eutectic temperature (183 °C). e. Explain the development of microstructure of a hypoeutectic Pb-Sn alloy on cooling from liquid region to room temperature.  **OR**	**20**	**CO2**

OR

Analyze the Fe-Fe_3C equilibrium phase diagram shown in the figure below and answer the following questions:

a. Write coordinates (composition, temperature) of all invariant points and write all the invariant reactions in this diagram.
b. Write composition range for steel, cast iron, hypoeutectoid and hypereutectoid steels.
c. Write the name of eutectoid product and using lever rule, determine the weight percent of ferrite and cementite in this eutectoid product at temperature just below the eutectoid temperature.
d. Write the name of eutectic product and using lever rule, determine the weight percent of eutectoid product and eutectic product in a hypoeutectoid steel having 1.5 wt.% carbon at temperature just below the eutectoid temperature.
e. Explain the development of microstructure of a hypereutectoid steel on cooling from liquid region to room temperature.