November/December 2022

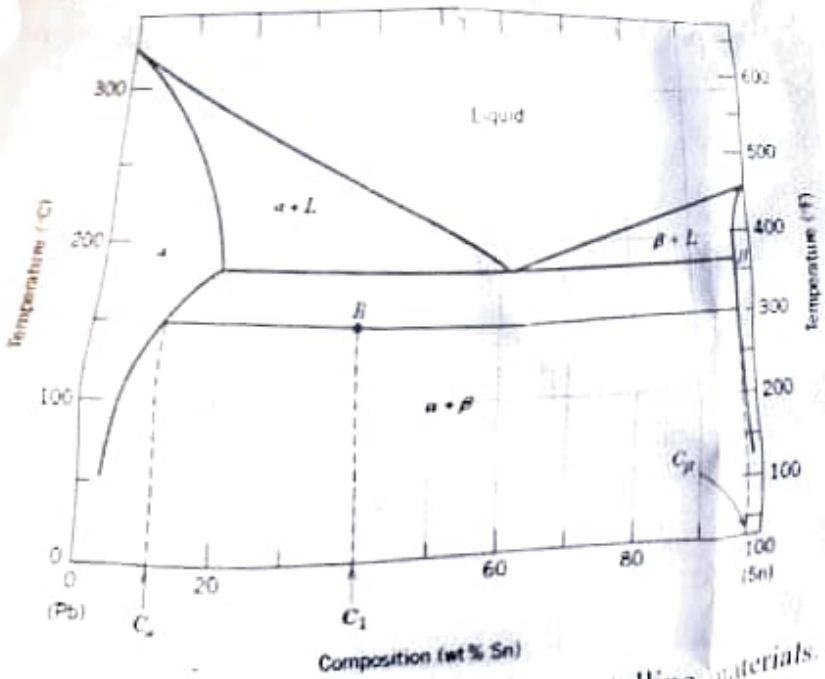
Course Title	MATERIALS SCIENCE AND ENGINEERING	Semester	Fall Semester 2022-23
Faculty Name	Prof. Narayanan R	Course Code	BMEE209L
Time	3 Hours	Slot	B1+TB1
Use of graph sheet is required for answering question number 6.		Class Nbr	CH2022231001670
		Max. Marks	100

Part A (10 X 10 Marks)
Answer any 10 questions

1. Explain the evolution of engineering materials in automobile and aerospace applications (metals to composites) over centuries. [10]

2. Why are copper and aluminium systems more workable than zinc or magnesium or titanium? Calculate (i) Atomic Packing Factor of BCC (ii) Planar Density (PD) and Planar Packing Density (PPD) of (110) plane of BCC? [10]

3. For a 40 wt% Sn–60 wt% Pb alloy at 150°C, calculate the relative amount of each phase present in terms of (a) mass fraction and (b) volume fraction. At 150°C take the densities of Pb and Sn to be 11.23 and 7.24 g/cm3, respectively. [10]



4. Discuss various defects present in the crystalline materials. Explain how the dislocations effect the ductility of crystalline materials. Elucidate effects of cold working and heat treatment process on mechanical properties with the help of recovery, recrystallization and growth of grain structures. [10]

5. Draw a hypothetical binary eutectoid diagram and explain the evolution of room temperature hypo-eutectoid, eutectoid and hyper-eutectoid microstructures. [10]

6. A specimen of ductile cast iron having a rectangular cross section of dimensions 8.0 mm 12.0 mm is deformed in tension. Using the load–elongation data shown in the following table estimate (a) through (f). [10]

(a) Plot the data as engineering stress versus engineering strain

(b) Compute the modulus of elasticity.

(c) Determine the yield strength at a strain offset of 0.002

(d) Determine the tensile strength of this alloy

(e) Compute the modulus of resilience.

(f)What is the ductility, in percent elongation?

Load		Length	
N	lb$_f$	mm	in.
0	0	75.000	2.953
4,740	1,065	75.025	2.954
9,340	2,055	75.050	2.955
12,920	2,900	75.075	2.956
16,540	3,720	75.113	2.957
18,300	4,110	75.150	2.959
20,170	4,530	75.225	2.962
22,900	5,145	75.375	2.968
25,070	5,635	75.525	2.973
26,800	6,025	75.750	2.982
28,640	6,440	76.500	3.012
30,240	6,800	78.000	3.071
31,110	7,000	79.500	3.130
31,280	7,030	81.000	3.189
30,850	6,930	82.500	3.248
29,180	6,560	84.000	3.307
27,190	6,110	85.500	3.366
24,140	5,430	87.000	3.425
18,970	4,265	88.725	3.493
	Fracture		

7. Describe (i) four strategies that are used for strengthening metals and alloys and (ii) three surface hardening processes and their applications. [10]

8. With the help of Fe-Fe$_3$C Phase diagram, explain the heat treatment process of (i) Full Annealing, (ii) Normalizing and (iii) Spheroidizing. Further explain the effect of quenching medium air, oil and water on mechanical properties. [10]

9. How is malleable iron obtained from white iron? [10]

10. Define hardenability of a steel material. Describe the Jominy end quench test and the method of obtaining hardenability of this material. [10]

11. Describe the techniques of production of polymer matrix composites. What is rule of mixtures applicable to composites? [10]

12. Explore applications of (i) Titanium alloys (ii) Magnesium alloys and (iii) Aluminum alloys in automobile and aerospace engineering. [10]