Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. (Full Time) - END SEMESTER EXAMINATIONS, NOV / DEC 2024

MATERIALS SCIENCE AND ENGINEERING
III Semester
MS23303 – PHYSICAL METALLURGY
(Regulation 2023)

Time: 3hrs | Max. Marks: 100

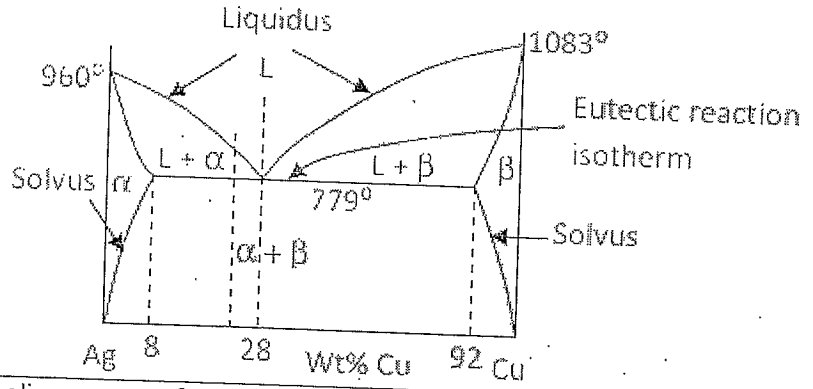
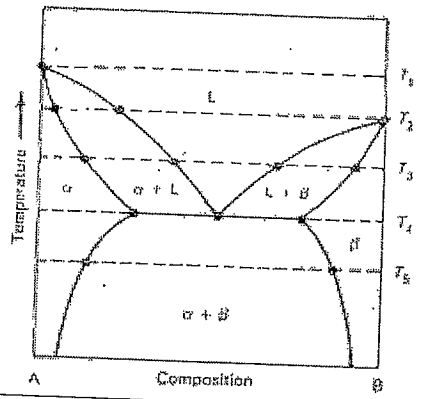
CO1	Explain the concepts of nucleation and growth of solids upon solidification
CO 2	Interpret the microstructural changes that takes place in the alloy systems and perform microstructural analysis of ferrous and non-ferrous materials
CO 3	Discuss on the mechanisms of deformation and the theoretical strength of crystals.
CO 4	Elaborate the various strengthening mechanisms and the basics of the Heat treatments adopted to get the desired properties
CO 5	Select suitable ferrous and non-ferrous materials for engineering applications & interpret the microstructures of various materials and also understand the effect of the various phase constituents on the properties of the materials.

PART- A(10x2=20 Marks)
(Answer all Questions)

Q.No	Questions	Marks	CO	BL
1	What are the factors that govern the formation of a substitutional solid solution?	2	1	1
2	What are the factors that determine the *'fraction transformed'* in a phase transformation process?	2	1	2
3	A material of unknown composition at atmospheric pressure exhibit four phases at 987 K. Find the minimum number of components in the system?	2	2	3
4	FCC is a more close packed structure yet solubility of carbon in FCC austenite is higher than that in ferrite which is BCC. Why is it so?	2	2	3
5	A Slip system has $\lambda=70^\circ$ and $\varphi=30^\circ$, slip starts at stress 35 MPa. What is the CRSS?	2	3	2
6	Zinc is brittle in nature whereas copper and aluminium are ductile in nature. Give reasons.	2	3	3
7	What types of alloys would respond to precipitation hardening?	2	4	3
8	Why are nickel base single crystal super alloys the most preferred material for gas turbine blades?	2	4	3
9	What are the factors that influence the grinding operation in metallography?	2	5	2
10	What is a suitable etchant for austenitic stainless steel? Write down its coposiiton.	2	5	2

PART- B(5x 13=65 Marks)

Q.No	Questions	Marks	CO	BL
11 (a) (i)	Derive the expressions for critical radius (r^*) and critical free energy (ΔG^*) required for homogeneous nucleation of a spherical	13	1	3

	nucleus of radius r.			
	OR			
11 (b)(i)	A liquid is cooled to a temperature T_r below its melting point, T_m. Show that the driving force for solidification is proportional to the undercooling given to the system. Assume latent heat of melting/ solidification is L.	4	1	3
(ii)	Draw an illustrative eutectic phase diagram and write down the eutectic reaction (with respect to the figure). What is a typical microstructure obtained, when a eutectic composition is slowly cooled?	9	1	3
12 (a) (i)	A molten Ag-Cu (20%) alloy is allowed to cool slowly till room temperature. Refer to the diagram below and plot its cooling curve. (3) Estimate percentage of pro-eutectic α and eutectic composition, just after it has solidified at 779°C& room temperature. (6) 	9	2	4
(ii)	Cooling curve of a binary alloy looks exactly similar to that of a pure metal. Is this possible? Give example and explain.	4	2	4
	OR			
12 (b)(i)	Draw the free energy composition curves for the various temperatures mentioned in the following phase diagram. 	13	2	4
13 (a)(i)	List the factors that are responsible to cause slip in a single crystal.	4	3	2
(ii)	State and derive the expression for Schmid's law.	9	3	2
	OR			
13 (b)(i)	Why does slip in metals usually take place on the densest packed planes?	3	3	2
(ii)	Explain the deformation mechanisms of slip and twinning in detail.	10	3	2
14 (a)(i)	Describe the precipitation sequence in Al-4%Cu alloy while subjecting the alloy to age-hardening heat treatment.	13	4	3

	OR			
14 (b)(i)	Discuss in detail the mechanism and theory of recovery, recrystallisation and grain growth during annealing of a cold worked material.	13	4	3
15 (a) (i)	Explain in detail the construction and the working principle of a metallurgical microscope.	13	5	3
	OR			
15 (b) (i)	Discuss in detail the procedural steps involved in the preparation of a sample for microscopic examination.	13	5	3

PART- C(1x 15=15 Marks)

(Q.No.16 is compulsory)

Q.No	Questions	Marks	CO	BL
16. (i)	A binary alloy having 28 wt % Cu & balance Ag solidifies at 779°C. The solid consists of two phases α & β. Phase α has 9% Cu whereas phase β has 8% Ag at 779°C. At room temperature these are pure Ag & Cu respectively. Melting points of Cu & Ag are 1083° & 960°C respectively. (a) Sketch the phase diagram. Label all fields & lines. (5). (b) Estimate the relative amount of α & β, their composition in the above alloy at 779°C & at room temperature. (5)	10	2	5
(ii)	Draw a binary phase diagram where A undergoes an allotropic transformation (but not B) and there are one eutectic and one eutectoid transformation.	5	2	5

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