Roll No.

CONTROLLER OF EXAMINATIONS ★ ADDITIONAL AU CHENNAI 600 025

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)
B.E. (Full Time) - END SEMESTER EXAMINATIONS, MAY / JUNE 2024
MATERIALS SCIENCE AND ENGINEERING
IV Semester
ML5404 &Heat Treatment of Metals & Alloys
(Regulation2019)

Time:3 hrs Max. Marks: 100

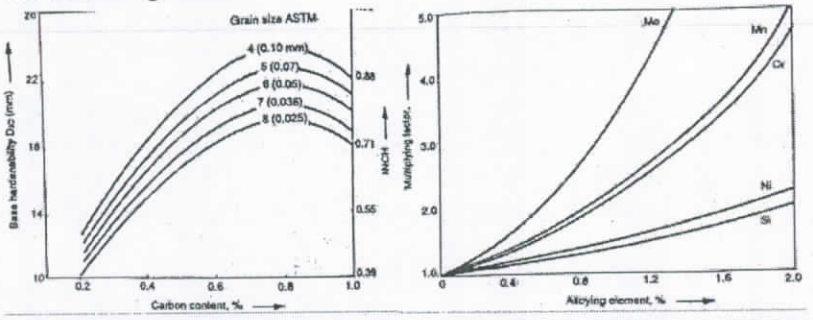
CO1	Discuss the various transformation reactions associated with the changes in microstructures and properties that occur due to controlled heat treatment.
CO 2	Explain the various heat treatment processes that can be applied for different ferrous and non-ferrous alloys.
CO 3	Analyze the effect of various case hardening treatments on the metals and alloys.
CO 4	Compare the various heat treatment furnaces, quenching media and furnace atmospheres.
CO 5	Interpret the results of heat treatments on the various other non-ferrous materials, alloy steels and cast irons.

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

Q.No	Questions	Marks	CO	BL
1	CCT curve of eutectoid steel is displaced towards right and lowered as compared to its TTT curve. Why?	2	1	L2
2	In a TTT curve, the incubation period is initially large, which decreases to a minimum (as the undercooking increases) at the nose of the curve and then again increases. Justify the statement.	2	1	L3
3	What is the effect of the presence of carbide forming elements that is not dissolved in austenite prior to hardening process?	2	2	L2
4	Austenitising range of hypoeutectoid steels for normalizing is higher than for annealing. Give reasons.	2	2	L2
5	Chromium increases the case depth of carburized steels whereas Nickel reduces the case depth of carburized steels. Justify the statement.	2	3	L3
6	Austenitising temperature for induction hardening is much higher for alloy steels than for plain carbon steels. Why?	2	3	L2
7	What do you mean by the inverse solubility of a polymer quenchant?	2	4	L2
8	What is the composition and maximum working temperature of Kanthal resistors?	2	4	L1
9	What is secondary hardening in alloy steels?	2	5	L1
10	What is the strengthening treatment adopted in alpha-beta titanium alloys?	2	5	L1

PART- B (5 x 13= 65 Marks)

Q.No	Questions	Marks	CO	BL
11 (a) (i)	Define Critical cooling rate and discuss the factors that affect the Critical cooling rate.	5	1	L2
(ii)	What is the effect of increased cooling rate of an austenitised steel on a. Temperature of transformation of pearlite b. Amount of proeutectoid phases c. Fineness of pearlite d. Hardness of the resultant structure	8	1	L2
	(OR)			
11 (b) (i)	Discuss on the influence of various parameters on the kinetics of austenitic transformation in steels.	8	1	L2
(ii)	Compare the characteristics of bainitic transformation with	5	1	L2

	pearlitic and with martensitic transformations.			
12 (a) (i)	Calculate the approximate value of D_I from Grossman factors for the steel with ASTM grain size no.6, and composition as follows: C-0.35%, Si-0.3%, Mn-0.7%, Cr-1.4%,Ni-1.4%, Mo-0.2%., using the following charts.  	5	2	L3
(ii)	Describe the heat treatment processes adopted to improve the machinability of steels upto 0.3% carbon and steels containing more than 0.5% carbon.	8	2	L3
	(OR)			
12 (b) (i)	What are the factors that influence the amount of retained austenite in hardened steels?	3	2	L3
(ii)	Discuss in detail the methods adopted to eliminate the retained austenite in steels with neat thermal cycle diagrams.	10	2	L3
13 (a) (i)	Enumerate the methods which can be used to obtain good surface hardness and impact resistance of the core.	3	3	L2
(ii)	Compare gas carburizing with that of carbonitirding in detail.	10	3	L2
	(OR)			
13 (b) (i)	Discuss in detail the various transformation hardening processes applied for achieving higher surface hardness.	13	3	L2
14 (a) (i)	Describe the general characteristics of a quenching medium needed to be considered for effective quenching of a heated component.	13	4	L2
	(OR)			
14 (b) (i)	Classify furnaces based on a. Source of heat, b. Type of heat treatment & c. Type of operation	5	4	L2
(ii)	Discuss in detail the three types of salt bath furnaces with neat diagrams.	8	4	L2
15 (a) (i)	Explain in detail the precipitation hardening of Al-4%Cu alloys with a neat thermal cycle diagram and the precipitation sequence.	13	5	L2
	(OR)			
15 (b) (i)	Describe briefly the heat treatment necessary to produce (a) black-heart malleable iron (b) Ductile iron	13	5	L2

PART- C(1x 15=15Marks)

(Q.No.16 is compulsory)

Q.No	Questions	Marks	CO	BL
16.(i)	Suggest a suitable heat treatment for an alloy steel containing nitride forming element to get good surface hardness and explain the process.	9	3	L3
(ii)	Discuss the effect of carbon on Quenching based on (a) Original structure, morphology of martensite. (b) Ms-M_f temperature, and thus resultant amount of phases (c) Hardness of martensite	6	2	L3