Course Code: 2040313 **Roll No:** **MLRS-R20**

MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)
Accredited by NBA and NAAC with 'A' Grade & Recognized Under Section2(f) & 12(B)of the UGC act,1956

II B.Tech II Sem Regular End Examination, July 2022

Metallurgy and Material Science

(MECH)

Time: 3 Hours. **Max. Marks: 70**

Note: 1. Question paper consists: Part-A and Part-B.
2. In Part – A, answer all questions which carries 20 marks.
3. In Part – B, answer any one question from each unit.
Each question carries 10 marks and may have a, b as sub questions.

PART- A

(10*2 Marks = 20 Marks)

1.	a)	Differentiate between metal and alloy.	2M	CO1	BL2
	b)	How the plane and directions are represented in unit cell of (1 0 0)?	2M	CO1	BL1
	c)	Draw the cooling curve for alloys and label the parts.	2M	CO2	BL1
	d)	Differentiate between equilibrium cooling and non-equilibrium cooling.	2M	CO2	BL2
	e)	Which elements in stainless steels give corrosion resistance?	2M	CO3	BL1
	f)	How much percentage of carbon is present in Cast Irons?	2M	CO3	BL1
	g)	Define the term hardenability.	2M	CO4	BL1
	h)	What is carburizing?	2M	CO4	BL3
	i)	What is the use of abrasive materials?	2M	CO5	BL1
	j)	What is the role of fiber in composites?	2M	CO5	BL1

PART- B

(10*5 Marks = 50 Marks)

2	a)	Define solid solutions. Explain in detail about the types of solid solutions.	5M	CO1	BL4
	b)	Mention the properties of electronic compounds.	5M	CO1	BL1
		OR			
3		Define Point Defects. Explain its classification with neat diagrams.	10M	CO1	BL4
4	a)	Explain the properties of Ferrite and martensite.	5M	CO2	BL4
	b)	Draw and label the Fe-Fe_3C phase diagram.	5M	CO2	BL1
		OR			
5		Explain with neat diagram the transformation of austenite to pearlite.	10M	CO2	BL4

6	a)	Explain the properties and applications of grey cast irons.	5M	CO3	BL4
	b)	Compare ferritic stainless steels and martensitic stainless steels.	5M	CO3	BL2
		OR			
7		Mention the composition and properties of tool and die steels.	10M	CO3	BL1
8	a)	What is tempering? Explain the different stages of tempering.	5M	CO4	BL4
	b)	Compare annealing and normalizing.	5M	CO4	BL2
		OR			
9		Suggest a suitable heat treatment to increase the case hardness of low carbon steels.	10M	CO4	BL4
10	a)	Define nanomaterials. Why nanomaterials are superior to other materials?	5M	CO5	BL1
	b)	Write the typical chemical composition of glasses? Explain the properties of glasses.	5M	CO5	BL4
		OR			
11		Classify composite materials. Explain the properties and applications of MMC.	10M	CO5	BL4

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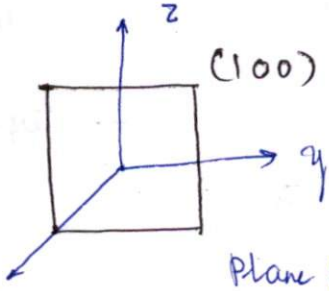
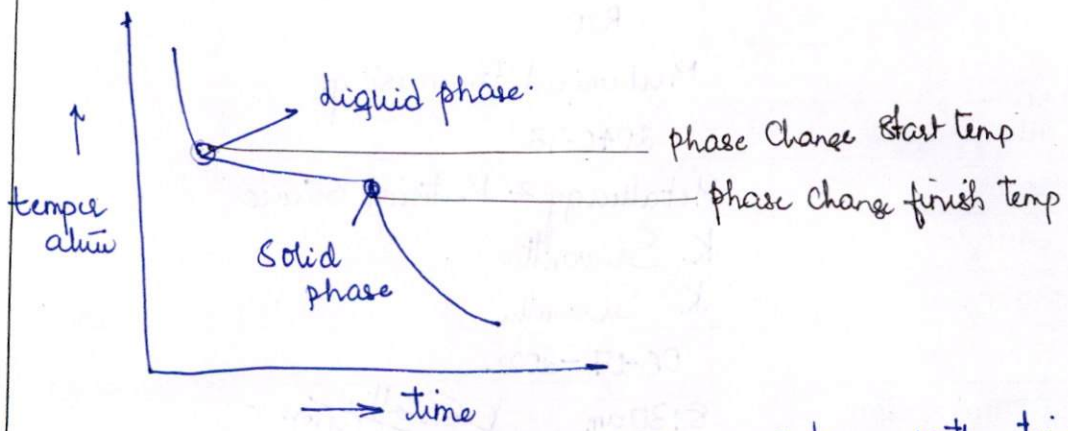
EXAMINATION BRANCH

Academic Year	2021 – 2022
Year & Semester	II B.Tech II Semester
Regulation	R20
Branch	Mechanical Engineering
Course Code	2040313
Course Name	Metallurgy & Material Science
Course Faculty's	K. Sravanthi
Course Moderator	K. Sravanthi
Date of Exam	06-07-2022
Reporting Time & Sign	8:30 am K Sravanthi 6/7/2022

KEY PAPER

QNO	ANSWER	MARKS
	Part: A	
1.		
a.	Metal: It is a pure substance ; Metallic properties ductile, Good Conductor of electricity Alloy: It is a mixture of two or more substance It can fixed & Variable Compounds. Can Changed as per the required properties.	2marks 1-metal 1m-alloy
b.	Miller indices are used to explain the Specify directions & planes in Crystals  Plane parallel to two axes but Cutting the third axis at length equal to one edge of unit cell.	2marks 1m-dia 1m-exp

QNO	ANSWER	MARKS
c.	Cooling Curve for alloys:—  It is a Graphical representation of Change in temp with time for a material over the entire temp range through which it cools. ⟶ phase diagrams.	Im-dia Im-exp (2m)
d.	Equilibrium Cooling Cooling rate is slow – desired micro structure— –No Sufficient time is available for the solute to diffuse – used in industries to make metal bars from the Molten State. Non equilibrium Cooling. Cooling process is at higher Cooling rate – here Sufficient time is available to diffuse – typical Solidifications or cooling process in industries is with Non equilibrium cooling.	Im equil Im Noneq (2m)

QNO	ANSWER	MARKS
e.	The Name of the Element is Chromium In General Stainless Steel Consists of 10% of Chromium. In Some cases Nickel also acts as Corrosion resistant element	2marks
f.	Cast Iron is a ferrous alloy. It Comprises more than 2% of Cast iron It Varies from 1.7 to 4.5.	2marks
g.	Hardenability :— Hardenability is defined as the ability of the steel to partially transform from austenite to Martensite at a given depth below the end surface, when cooled under a given condition (or) it is the depth to which a matial is hardned after putting it through a heat treatment process.	def 2m
h.	Casburizing :— It is a thermochemical process in which Carbon is diffused into the surface of low Carbon steels to increase the Carbon content to Sufficient levels, so that Suface will respond to heat treatment and produce a hard, wear resistant layer.	def 2marks

QNO	ANSWER	MARKS
i.	Use of abrasive matriale : They are hard Crystals found in nature or manufactured. eg: Aluminium oxide Silicon Carbide diamond. * Commerical & domestic use finish or Shape a work piece — Buffing, Honing, Drilling, Grinding, Sanding, Polishing, Cutting → diesel Engine Needle → Collets for Chucks → piston rings.	1m + 1m 2marks
j	Role of fibers in Composites. — Contributes tensile stength → enhancing performance properties. → Stength & Stiffness. → minimizes weight :	1/2m each point 2m

QNO	ANSWER	MARKS

Part - B

2.

a. Solid Solutions :

It is a mixture of two Crystallic Solids that Coexist as new Crystallic solid. or Crystal lattice

Consits of two or more types of atoms or molecules -

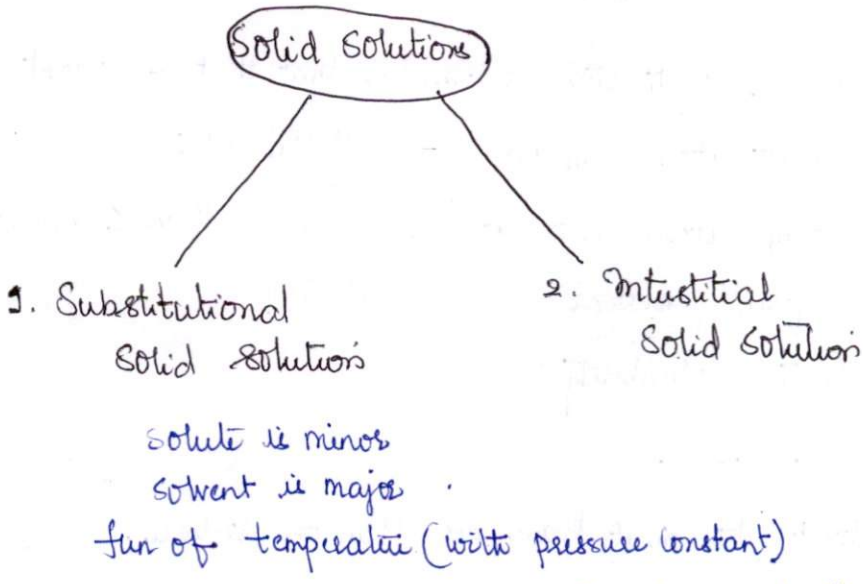
Solvent is in Greater amount.

Solute is in a minor Concentration.

They have important Commuical & industrial applications.

have Superior properties Compared to pure materials.

Many Metals are solid solutions -



1 marks

Solute is minor
Solvent is major
fun of temperature (with pressure constant)

(a) unsaturated (b) Saturated (c) Super saturated

QNO	ANSWER	MARKS

Substitutional Solid Solution :—

Size of Solute atom similar to solvent atom

Solute atom can replace solvent atoms

Ex :—

Brass, Zinc(Solute) ⟶ Cu (solvent) (2m)

Conditions

1. two elements must have same Crystal structure
2. diffrence in atomic radii should be less than 15%

Interstitial Solid Solution :—

Size of solute atoms is smaller that that of solvent atoms

Solute atom can occupy interstitial positions

only atoms with atomic radii less than 1 angstroms form interstical solid solutions. (2m)

limited Solubility

Conditions :—

1. Solvent atom must have more than one valence.
2. atomic radius of solute atom must be less than 59% of the atomic radii of solvent atom.

QNO	ANSWER	MARKS
	Ex:— Steel. Carbon atoms present in interstitial positions between iron atoms with maximum percentage of 2. Atomic radius of Carbon is 0.071nm which is less than 59% of 0.125nm radius of iron atom.	Total (5m)
B)	Properties of Electronic Compounds :— — high temperature Super Conductivity — — Colossal magneto resistivity — — high dielectric — — or thermoelectric response — — Complex atomic & Nanoscale Structs — — Critically important performance — electrical — optic — Magnetic — thermal properties	5points (5M)

QNO	ANSWER	MARKS
3.	Point Defect:—	

defects in Crystal which occurs around an atom or particle.

occurs only at a single lattice point.

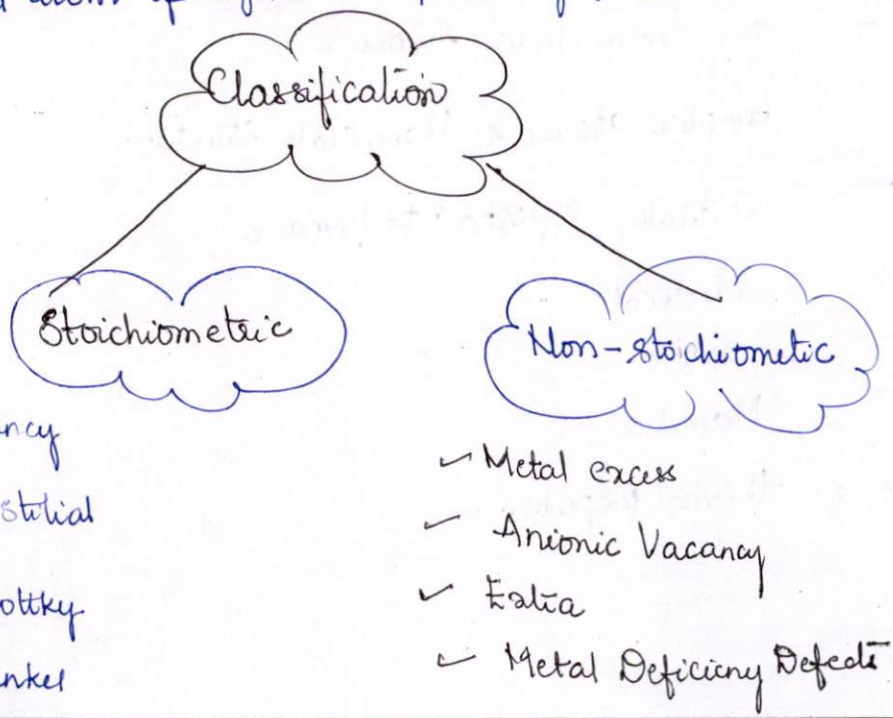
do not extend in space in any dimension

Zero dimensional defects —

Point defects occur when:—

1. One or more atoms missing in crystal lattice site
2. atoms shifted from its corresponding lattice site to interstitial position
3. foreign atoms occupy the interstitial position
4. Original atom of Crystal is replaced by foreign atom

1m
2.5m

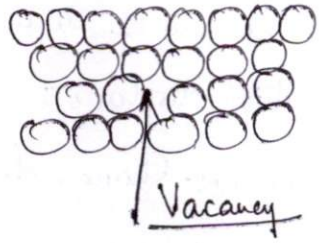
1. 

2m 5m

QNO	ANSWER	MARKS

a. Vacancy defect: —

when atom goes missing from its original lattice
it Creats a Vaccancy.



decreases density of substance.
depends on temp of Crystal.
due to unipefect packing during Crystallization

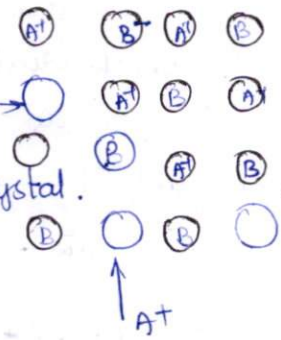
~~2m~~ 2(5m)

b. Intistitial Defect: —

atoms takes intistical position
atom can be from same or different Crystal
increase density of crystal.
Causes atomic distortion

c. Schottky defect: —

occurs in ionic crystals
size of Cation and anion is similar.
heat is applied to ionic compound crystal.
reduces density of ionic compound —



QNO	ANSWER	MARKS

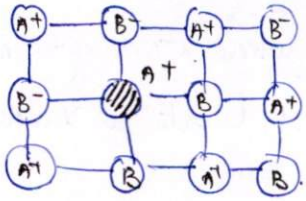
d. Frenkel Defect :—

Observed in ionic compound.

ions are of diffuent size

Cation displaces to interstial voids

does not change density of crystal.



Non – stoichiometric defects :—

disturb the stoichiometry of the compound or Crystals.

2m

a. Metal Excess defects :—

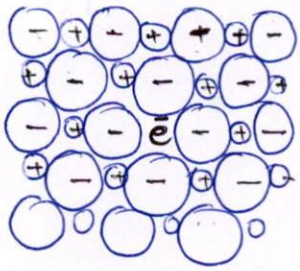
Metal ions excess.

2.5m

Anionic Vacancy

Anion goes missing which Creates Vacancy; this Vacancy is occupied by an electron —

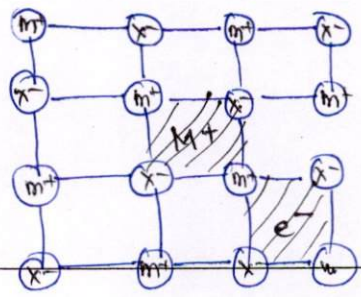
'F" Centre – it gives color



Extra Cation

extra Cation fits into interstial site.

Equal number of electrons do the same to maintain electrical neutrality of the Crystal —

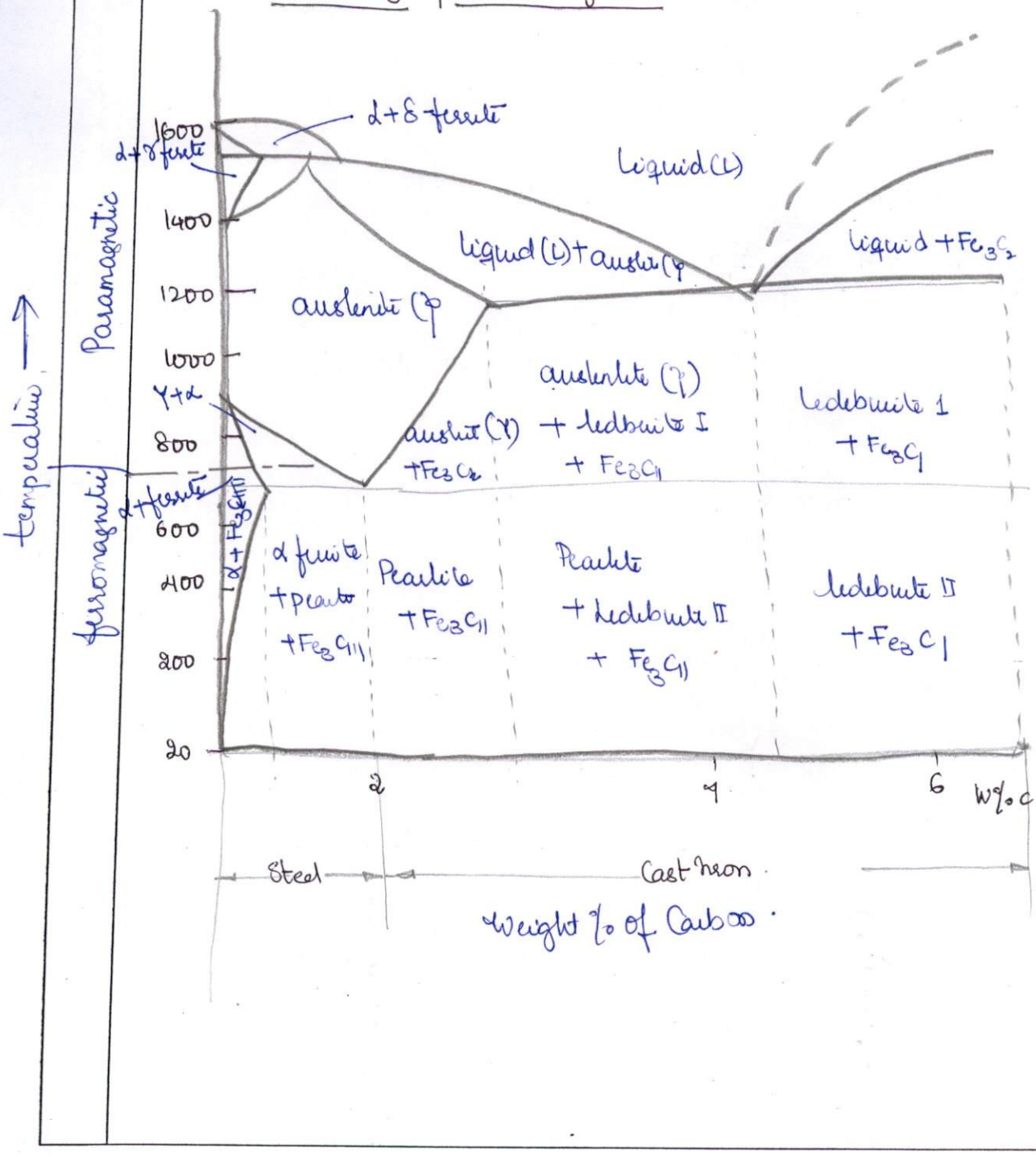


Total 10m

QNO	ANSWER	MARKS
4 a.	Properties of Ferrite: Ceramic like Material with Magnetic properties. used in electronic devices. Brittle, hard, iron Containing. Black or Grey in color. Composition :- derived from iron oxides. Fe_3O_4 Poor & hard Conductor of electricity. AB_2O_4 A → metal Cation. B → Metal Cation Fe iron ✓ Strong Magnetic property ✓ Relatively low Conductivity ✓ low eddy Current ✓ Low dielectric losses. ✓ high Permeability ✓ high electrical Resistance.	2.5m

QNO	ANSWER	MARKS
	Properties of Martensite :— Metastable Structure— BCT Crystal Structure— It is formed when in (steels) cooling rate from austenite is at such a high rate that Carbon atoms do not have time to diffuse out of Crystal Structure— Properties :- high — hard — strong — Slightly Brittle — moderate Corrosion resistance. — are magnetic — Strength ✓ — low work hardening Behaviour.	2.5M Total 5M

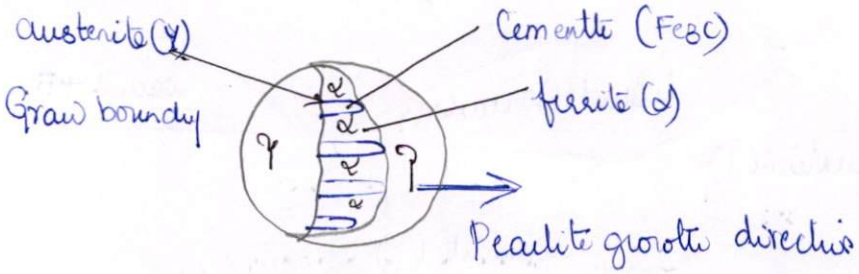
QNO	ANSWER	MARKS
4 (b)	Fe- Fe_3C phase diagram	5 marks



QNO	ANSWER	MARKS
5.	Transformation of austenite to Pearlite :	

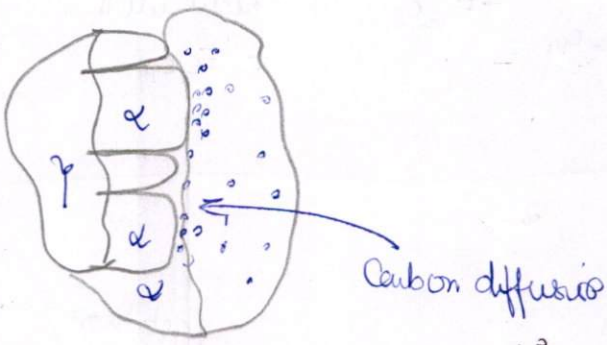
Fe-Fe_3C Eutectoid transformation

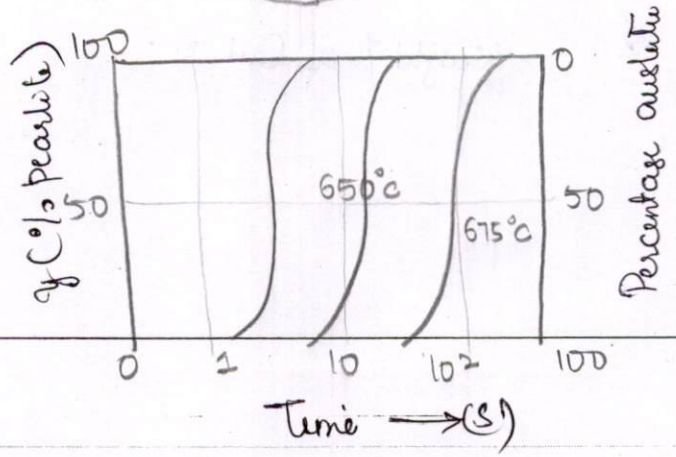
Austenite to Pearlite



Diffusion of C during transformation

5m



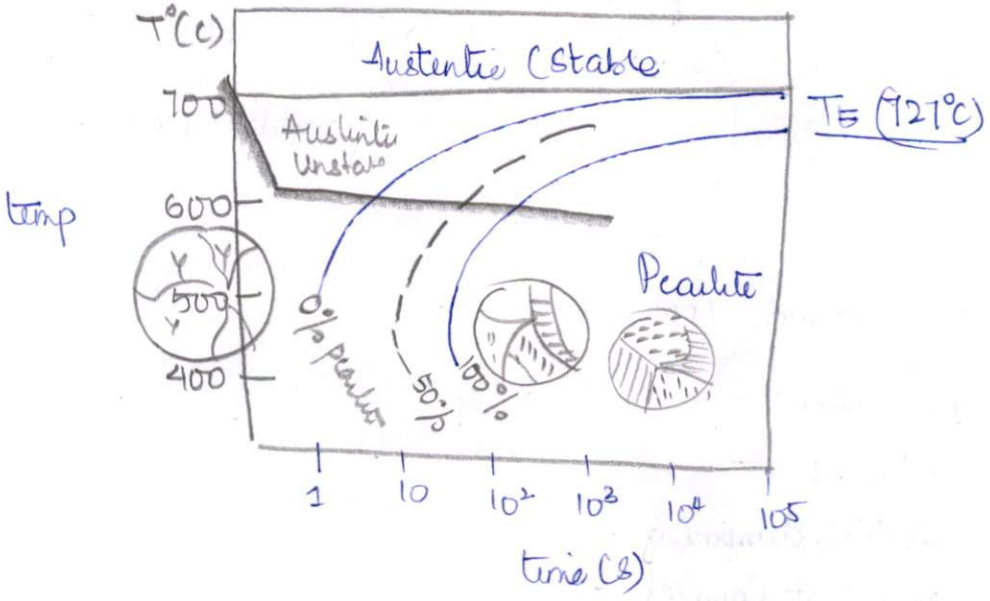


QNO	ANSWER	MARKS

Coarse pearlite → formed at higher temp → relatively soft

fine pearlite → formed at lower temp → relatively hard

Isothermal transformation



5m

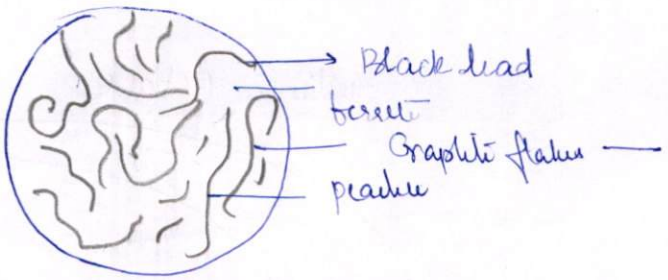
Eutectoid Composition $C_0 = 0.76 wt\%C$

Begin at $T > 727°C$

Rapidly cool to 625°C.

Hold T (625°C) constant (isothermal treatment)

Total (10m)

QNO	ANSWER	MARKS
6		
a.	Properties & applications of Grey Cast iron	
	Gray iron dark Grey fracture color Graphitic Microstructure. Graphite flakes → due to addit of Silicon, 2.5 wt% — 4.0 wt% Carbon — 1.0 wt% — 3 wt% Silicon.	1m 1.5m
		
	Grey Cast iron Applications :— high Stiffness machinability vibration dampening. high heat Capacity high thermal Conductivity	1.5m 1m
	→ internal Combustion engine → Cylinder blocks → fly wheels → Gearbox Cases, disk brake rotors, Cookware. → manifolds	Total 5m

QNO	ANSWER	MARKS
B)	Ferritic Stainless Steel.	
	Most widely used steel.	1m
	low levels of Carbon	
	high amounts of Chromium —	1m
	ductility	
	Corrosion - resistance	
	Magnetic properties	0.5m
	Bcc Structure.	
	Cookers, magnetic fastners —	
	dishwashers, Kitchen sinks, food processing equipment	
	Automobile Industry nuclear reactors —	
	Martensitic Stainless Steel.	1m
	Hardness.	
	high Strength	
	wear resistance.	
	Corrosion resistance —	1m
	ferromagnetic —	
	high hardness —	
	heat exchangers —	0.5m
	aerospace applications.	5 mark
	high Young's Modulus —	

QNO	ANSWER	MARKS
7.	Composition & properties of tool & die steels — Tool steels high quality — Carbon alloy steels — used to make Cutter, reamers, bits etc Machining Metals, Plastics & wood. usually melted in furnaces & processed to give the properties required for shaping other metals into useful Components — with stand high temperature — heavy loads — Contains. Carbide formers like ~ Chromium ~ Vanadium ~ Molybdenum ~ tungsten — ~ Cobalt ~ Nickel.	2.5 2.5

QNO	ANSWER	MARKS

High Speed Steels — Water hardening
Hot work steels — Shock-resisting.
Cold work Steels — low-alloy special-purpose
low-Carbon mold steels

Properties

Toughness
Wear resistance
Hardness
Heat-resistance

Application

forming
Stamping
Cutting Shears of plastics & metals.
Extrusion of plastic sections.
Stamps of steel coils.
Dies of Compacting

Total
10 1/2 only

QNO	ANSWER	MARKS

Die Steels

Cold work steels
high Carbon
high Chromium —

Good resistance at elevated temp
high hadness —
Good Wearig properties —

---

critical Sections —
dies of blankeg
coinig.
tollus threadeg —
drop forgeg —

---

high Carbon alloy steel
air hardeig —

Sharp knob, Scissors, Saw, cold or hot —
saw pattin, hir mode, Cuttin -
impact mode —
Mandrel —

2½

2½

QNO	ANSWER	MARKS
8 a.	Tempering:— process of improving the Characteristics of a metal, especially steel, by heating it to a high temperature — Below the Melting point - cooling in air — toughness of material increases — hardness of material decreases —	2\5
	Stages of Tempering	
	1. first stage of tempering up to 200°c — precipitation of ε (epsilon) — Carbide due to decrease of tetragonality of martensite	
	2. Second stage of tempering :— 200°c to 300°c — Decomposition of retained — austenite	2\5
	austenite % 60 40 20 0 0.4 0.8 1.2 1.6 Carbon wt%	
	3. third stage:— Carbon ε- Carbide dissolves in matrix low - tetragonal Martensite loses —	
	(4) fourth stage of temp Growth & Spheroidization of Cementite — recovery & recrystallization	5 Marks

QNO	ANSWER	MARKS
b)	**Annealing**	
	a. Main purpose of annealing is to relieve internal Stresses.	
	b. Less hadness, more tensile strength	
	c. Tensile Strength is reduced after annealing.	
	d. Grain size is changed to larger in the internal Structure.	
	e. Pearlite is Coarse	
	f. Internal Stresses are least	
	Normalizing	
	a. To improve Mechanical properties of steel.	
	b. more hardness, less tensile strength toughness	2.5 + 2.5
	c. It is done after forging	
	d. Grain size is changed to Very small in the internal structure	5 Marks
	e. Pearlite is fine	
	f. Internal Stresses are slightly more	

QNO	ANSWER	MARKS
9	Suitable heat treatment to increase Case hardns of low Carbon Steel. Induction Hardenig — Hardening of Surface parts. used to increase wear resistance. un affected Core Micro Stuchin —	2½
	Process : — Parts are heat treated are placed inside a copper coil heated above their transformation temp. it includes alterative magnetic field —	2½
	Benefits : — Components of heavy loadis —	2½
	Applications : — Gears, Shafts — axles, Cam lobes, Stampings, Spindles etc —	2½ 10 Mark

QNO	ANSWER	MARKS
10 a)	Nano Matials. Matial processig at minimum, one extrial dimensios 1–100nm. Occus naturally Or man made– Or by products of Combustios reactios. ↙ different physical & Chmical propeties– Uses: – Health Care Cosmetics → transporations of Chemothrapty drugs directly to Cancerous growth – – ex: Carbon Nanotubes to Create bactria Sensors – aerospace – morphig aircaft wigs– Examples: – titanium oxide Carbon Nano tubes antimicrobial Nano technology. Mobile pigment Nano particles–	2½

QNO	ANSWER	MARKS
	Advantages :— (Superior to other Materials)	
	high porosity	2½
	Generating energy.	
	More efficient	
	Cost efficient	5 Marks
	Increase in the accuracy of the Construction of electronic Circuit —	
10 B)	Chemical Composition of Glasses :—	
	Non Crystalline.	
	inorganic compound	
	Silica & Silicon dioxide.	
	Mineral — quartz	
	Glass Examples: • Obsidian (• Fulgurites • Moldavite	Man made: • Teinglass • Fluoro-aluminate • Polystyrene. 2½

QNO	ANSWER	MARKS
	Properties of Glass:—	
	• It is a matial of natiral products	2.5
	• It is an inorgnic solid Matial.	5 Marks
	• Glass can withstad high temperatiu—	
	• 100% recyable	
11 a.	Composite Matial:—	
	also called as Composite,	
	two or more substanco, each with its own Characticts —	
	are combined to creati a new substane whose propeti	
	are superior	2.5
	Classificatios	
	↳ polymer matix Composites (PMC's)	
	↳ Metal Matix Composiu (MMC's)	
	↳ Ceramic Matix Composiu (CMC's)	
	↳ Carbon Matix Composiu (CAMC's)	

QNO	ANSWER	MARKS
	Matix phase primary phase — ductile, less hard phase — Reinforcing Second phase — stronger than the matix, Metal Matix Composite :- 1. Higher temp Capability 2. Fire resistance. 3 Higher transverse stiffness & Strength 4. No moisture absorption 5. Higher electical & thermal Conductivity. 6. Better radiation resistance. 7. No outgassing.	2.5 2.5

QNO	ANSWER	MARKS

Applications: —

Aerospace & Aircraft Industry —

transmission systems

Gear boxes

engine parts —

accessories —

Sports:-

Strength to weight ratio

tennis rackets

bicycle frames

rotorcraft speed & strength

Automotive Applications

Car & motor racing.

engine

Vechile body parts —

light weight

215

10 Marks

6/3/2022