SRM VALLIAMMAI ENGINEERIN COLLEGE

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK



III SEMESTER

ME3364 - ENGINEERING METALLURGY AND MATERIAL TESTING

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Prepared by

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SUBJECT: ME3364 - ENGINEERING METALLURGY AND MATERIAL T

SEM / YEAR : III/ II

UNIT-I/ BINARY PHASE DIAGRAM

Solid solutions: Substitutional and interstitial – Compound – Phase diagram: Classification - Phase reactions with an example: Isomorphous, eutectic, eutectoid, peritectic and peritectoid, Iron – Iron carbide diagram.

Q.No.	PART-A (2 Marks)	BT Level	Competence
1.	What is peritectic reaction? Write an example for that reaction.	BT-1	Remember
2.	What is eutectoid reaction? Write an example of the eutectoid reaction occurring in the iron carbon system.	BT-1	Remember
3.	Define alloy.	BT-1	Remember
4.	Define alloying elements	BT-1	Remember
5.	How will you explain peritectic reaction?	BT-2	Understand
6.	What is steel?	BT-1	Remember
7.	State the condition for Gibb's phase rule.	BT-1	Remember
8.	Differentiate between substitution and interstitial solid solutions.	BT-2	Understand
9.	What is invariant Reaction?	BT-1	Remember
10.	Define the term solid solution	BT-1	Remember
11.	Define the term "ferrite" and "Austenite" in iron – carbon alloy system.	BT-1	Remember
12.	Define "allotropy of iron"	BT-1	Remember
13.	Why carbon solubility is more in Austenite?	BT-2	Understand
14.	State Gibb's phase rule.	BT-1	Remember
15.	How do cast irons differ from steels in terms of carbon content?	BT-2	Understand
16.	Write the different types of cast iron	BT-1	Remember
17.	Define isomorphous.	BT-1	Remember
18.	Define Eutectic Reaction. Give an example.	BT-1	Remember
19.	Write the Classification of steel.	BT-1	Remember

20.	Write the constitution of austenite.	BT-1	Remember
21.	Define eutectoid reaction	BT-1	Remember
22.	What is meant by solidus?	BT-1	Remember
23.	What is meant by liquids?	BT-1	Remember
24.	What are cooling curves?	BT-1	Remember
25.	What is an equilibrium phase diagram?	BT-1	Remember
Q.No.	**PART-B (16 Marks)**	**BT Level**	**Competence**
1.	Explain briefly Isomorphous phase diagram for Cu-Ni system and Ideal phase diagram (soluble and insoluble)	BT-4	Analyze
2.	Explain types of cast iron? Draw the microstructure of any four types of cast iron?	BT-4	Analyze
3.	How will you plot binary phase diagram for two metals which are completely soluble in liquid and solid states?	BT-4	Analyze
4.	Explain the following invariant reactions with reference to a phase diagram (a) Eutectic reaction (b) Eutectoid reaction	BT-4	Analyze
5.	Explain the following invariant reactions with reference to a phase diagram (a) Peritectic reaction (b) Peritectoid reaction.	BT-4	Analyze
6.	i) What is the micro constituent of iron carbon alloys? Explain the general characteristics of each? ii) Draw the typical microstructure of 1.2%C steel at 920˚C 780˚C and 200˚C.	BT-3 BT-3	Apply Apply
7.	Draw Iron-iron carbide equilibrium diagram and mark on it all salient temperatures and composition fields.	BT-3	Apply
8.	Explain the phase reactions occurring in Fe-Fe3C system. What are the temperatures and compositions at which they occur?	BT-3	Apply
9.	Explain the primary crystallization of eutectoid steels, hypo-eutectoid steels and hypereutectoid steels.	BT-3	Apply
10.	Explain the primary crystallization of eutectic cast irons, hypoeutectic cast irons and hypereutectic cast iron with the help of neat sketch.	BT-4	Analyze
11.	Explain properties and applications of cast iron types.	BT-4	Analyze
12.	Draw Fe-C diagram and mark all the phases and explain the reactions.	BT-3	Apply
13.	i) Draw the phase diagram between A and B, if the two metals are	BT-3	Apply

	completely soluble in solid and liquid state. ii)Discuss the similarities and differences between substitutional and interstitial solid solution?	BT-2	Understand
14.	(i)Elements A and B melt at 700° C and 1000°C respectively. Draw a typical isomorphous phase diagram between the elements A and B. (ii)Elements A and B melt at 700° C and 1000°C respectively. They form an eutectic at 35% A at temperature 500°C. Draw a typical phase diagram between A and B.	BT-3	Apply
15.	Draw a hypothetical phase diagram A-B with the help of following data: (a) Melting point of A = 1100°C (b) Melting point of B = 1300°C (c) Eutectic reaction occurs at 1000°C at 40% B composition. (d) maximum solubility of B in A and A in B at eutectic temperature in 10% and 5% respectively which drops down to zero at 0°C. Mark each line and area. How the structure of alloy will change if alloy containing 10% B composition is cooled from liquid state?	BT-3	Apply
16.	Draw Iron-Carbide equilibrium diagram and mark on it all salient temperature and composition fields.	BT-5	Evaluate
17.	Draw a typical isomorphs phase diagram and explain the structural changes of alloys (say 50% A and 50% B). Apply the lever rule at some temperature in alpha + liquid portion for this alloy	BT-3	Apply
18.	Two elements A and B have melting points 800°C and 600°C respectively (i) Draw a phase diagram between A and B if they exhibit unlimited solid solubility. Draw a phase diagram between A and B if they exhibit unlimited. (ii) Draw a phase diagram between A and B if a eutectic reaction occurs at composition 40%B and at temperature 400°C. Assume that the maximum solid solubility in either case is 5% and the room temperature solubility in either case is 1%	BT-5	Evaluate

UNIT- II / HEAT TREATMENT PROCESSES

Full, stress relief, recrystallization and spherodizing annealing – normalising, hardening and tempering of steel – phase transformation - Isothermal transformation (TTT) diagram for Eutectoid Steel – cooling curves - CCR – Hardenability - Jominy end quench test – Austempering - martempering. Case hardening - carburising, nitriding, cyaniding, carbo- nitriding, flame and induction hardening

Q.No.	PART-A	BT Level	Competence
1.	Define Normalizing and Hardening process.	BT-1	Remember
2.	Define recrystallisation	BT-1	Remember
3.	What is the use of the isothermal transformation diagram?	BT-1	Remember
4.	Name the various method of heat treatment of steel.	BT-1	Remember
5.	What is meant by Stress relief annealing and Spheroidizing.	BT-1	Remember
6.	Define Hardenability.	BT-1	Remember
7.	Define the term heat treatment.	BT-1	Remember
8.	What are the purposes of processing heat treatments?	BT-1	Remember
9.	Write the purpose of annealing.	BT-1	Remember
10.	Define CCR.	BT-1	Remember
11.	What is T-T-T diagram?	BT-1	Remember
12.	Enumerate Martempering?	BT-1	Remember
13.	Define Quenching.	BT-1	Remember
14.	Define tempering.	BT-1	Remember
15.	What do you mean by the term case hardening?	BT-1	Remember
16.	What is austempering?	BT-1	Remember
17.	Differentiate carburizing and nitriding.	BT-2	Understand
18.	What is laser surface hardening?	BT-1	Remember
19.	What is flame hardening?	BT-1	Remember
20.	Mention few applications of induction hardening	BT-1	Remember
21.	List the various stages of a heat treatment process.	BT-1	Remember
22.	List some of the important heat treatment operations widely used.	BT-1	Remember
23.	What is meant by annealing?	BT-1	Remember
24.	What are the three stages for quenching.	BT-1	Remember
25.	List the different types of annealing.	BT-1	Remember

Q.No.	PART-B:	BT Level	Competence
1.	Draw a neat sketch of the TTT diagram for eutectoid steel and label the regions. Mark the different products formed on this diagram.	BT-3	Apply
2.	What is a CCT diagram? Explain various cooling curves on CCT diagrams.	BT-3	Apply
3.	How CCT curves are drawn? Explain critical cooling rate.	BT-3	Apply
4.	Explain how Jominy end quench test is used for determining the hardenability of steels.	BT-3	Apply
5.	i) What is meant by hardenability? Explain a method of measuring hardenability of alloy steel. (ii) Distinguish between diffusion and thermal surface hardening treatments.	BT-3	Apply
6.	Explain tempering process.	BT-4	Analyze
7.	Define the types of annealing Process and explain them.	BT-4	Analyze
8.	Explain: 1.Annealing 2.Spheroidising 3.Normalising 4. Hardening	BT-4	Analyze
9.	Explain the process of nitriding. List and discuss the advantages of nitriding over carburizing	BT-4	Analyze
10.	What is meant by carburizing of steels? Briefly explain the various types of carburizing.	BT-4	Analyze
11.	Explain:1. Carburizing 2.Cyaniding 3.Nitriding 4.Carbonitriding	BT-4	Analyze
12.	Explain age hardening.	BT-4	Analyze
13.	Explain the following case hardening process: i) Induction hardening ii) Flame hardening	BT-4	Analyze
14.	Enumerate Martempering and Austempering.	BT-3	Apply
15.	With a schematic layout explain the following: Vacuum and Plasma hardening	BT-4	Analyze
16.	Explain the difference between TTT diagram and iron –carbon equilibrium diagram.	BT-4	Analyze
17.	Describe why are TTT diagrams usually not applicable to industrial engineering practices?	BT-4	Analyze

18.	Outline the principle of high frequency induction hardening. How induction hardening is carried out. Mention its advantages, disadvantages and applications.	BT-4	Analyze

UNIT- III / FERROUS ALLOYS

Classification, properties, microstructure, processing and applications of low, medium & high carbon steel & FG, SG, White, Malleable cast iron – effect of alloying elements on steel (Cr, Mo, V, Ti, Ni & W) - stainless steel and tool steels - HSLA steel & Maraging steels – Die steel, Wear of Metals - BIS Specification.

Q.No.	PART-A	BT Level	Competence
1.	Define stainless steels.	BT-1	Remember
2.	What is meant by maraging steel?	BT-1	Remember
3.	Define tool steel.	BT-1	Remember
4.	Name some of the Tool steel.	BT-1	Remember
5.	Write the classification of steel?	BT-1	Remember
6.	What is Hypoeutectoid and Hypereutectoid steel?	BT-1	Remember
7.	Describe precipitation hardening.	BT-2	Understand
8.	State three reasons why ferrous alloys are used extensively.	BT-2	Understand
9.	Write the constitution of Stainless steel.	BT-1	Remember
10.	State three characteristics of ferrous alloys that limit their utilization.	BT-1	Remember
11.	How the steel classified?	BT-1	Remember
12.	List four important alloying elements added in alloy steels.	BT-1	Remember
13.	What are the required good properties of a tool steel?	BT-1	Remember
14.	Define 18-4-1 high speed steel.	BT-1	Remember
15.	Define chilled cast iron.	BT-1	Remember
16.	Define the process “precipitation hardening”.	BT-1	Remember
17.	Describe HSLA? Where it is used?	BT-2	Understand
18.	What are the types of cast iron?	BT-1	Remember
19.	Write the effect of chromium and molybdenum in low alloy steels.	BT-2	Understand
20.	What are different alloys steels?	BT-1	Remember
21.	What are ferrous alloys?	BT-1	Remember
22.	What are different nonferrous alloys?	BT-1	Remember
23.	What are the features that make cast iron an important material?	BT-2	Understand
24.	What are the effects of carbon on the properties of cast iron?	BT-2	Understand
25.	What is the influence of cooling rate on the properties of a cast iron?	BT-2	Understand

Q.No.	**PART-B:**	BT Level	Competence
1.	Explain the influence of various alloying element addition in steels	BT-3	Apply
2.	Discuss the composition, properties, application- Maraging steels, Tool steel, HSLA	BT-3	Apply
3.	Discuss the composition, properties, application of different types of cast irons.	BT-3	Apply
4.	What are stainless steels? Explain are the main characteristics of stainless steels?	BT-3	Apply
5.	Name different types of stainless steels and explain their main applications?	BT-3	Apply
6.	Discuss the influence of each of the following alloying elements on the properties of steel: (a) Molybdenum (b) Chromium (c) Manganese (d) Vanadium (e) Titanium (f) Tungsten.	BT-3	Apply
7.	Describe the structures of the main types of cast irons and account for their continued use as engineering materials	BT-3	Apply
8.	Explain the steps involved in precipitation hardening treatment.	BT-3	Apply
9.	Explain the following materials in terms of composition properties and application (i) Maraging Steel (ii) Austenitic Stainless Steel (iii) Alpha Beta Brass	BT-3	Apply
10.	Describe the properties and typical applications of low, medium, and high- carbon steels.	BT-3	Apply
11.	What is an alloy steel? How are alloy steels classified? Explain them.	BT-3	Apply
12.	What are HSLA steels? How can high strength and toughness be attained in them?	BT-3	Apply
13.	Compare grey and malleable cast irons with respect to (i) composition and heat treatment, (ii)microstructure, and (iii) mechanical characteristics.	BT-3	Apply
14.	Compare white and nodular cast irons with respect to (i) composition and heat treatment, (ii) microstructure, and (iii) mechanical characteristics.	BT-3	Apply

15.	Classify stainless steel and tool steel and explain following (i) Maraging steel(ii) Spheroidal cast iron (ii) HSS Steel in terms of composition property and use.	BT-3	Apply
16.	Explain about a. Gray C.I b. White C.I c. Malleable C.I d. Spheroidal Graphite C.I	BT-3	Apply
17.	Write the composition and applications of a) Stainless steel b) Tool steel.	BT-3	Apply
18.	Explain Die steel and Wear of metals	BT-3	Apply

UNIT- IV / NON FERROUS ALLOYS

Properties, Composition, Applications: Copper and its alloys - Brass, Bronze and Cupronickel – Aluminium and its alloys – Duralumin- Bearing alloys. Nickel and Titanium base alloys – Metals for low and high temperature applications- BIS Specification.

Q.No.	**PART-A**	**BT Level**	**Competence**
1.	What are bearing materials?	BT-1	Remember
2.	Enumerate the important types of copper alloys.	BT-1	Remember
3.	Describe precipitation hardening.	BT-2	Understand
4.	What is meant by cupronickel?	BT-1	Remember
5.	What is the main strengthening mechanism in high strength aluminum alloys?	BT-1	Remember
6.	State the effect of chromium in low alloy steels.	BT-2	Understand
7.	Define super alloys.	BT-1	Remember
8.	How copper alloys classified?	BT-1	Remember
9.	Which alloy elements are basically (a) carbide formers (b) graphite promoters?	BT-1	Remember
10.	What is the effect of chromium alloying element on the properties of steel?	BT-1	Remember
11.	Name any two types of aluminium alloys.	BT-1	Remember
12.	Define the term copper.	BT-1	Remember
13.	Name the industrially important copper alloys.	BT-1	Remember
14.	List some bronze alloys.	BT-1	Remember
15.	Write the effect of molybdenum in low alloy steels.	BT-1	Remember

16.	Mention any two aluminium base alloys and their applications.	BT-1	Remember
17.	What is phosphor bronze? State its applications.	BT-1	Remember
18.	What is high brass?	BT-1	Remember
19.	Define low temperature non ferrous metals.	BT-1	Remember
20.	What is the use of monel metal?	BT-1	Remember
21.	Define high temperature non ferrous metals.	BT-1	Remember
22.	Name any four low temperature non ferrous metals.	BT-1	Remember
23.	Name any four high temperature non ferrous metals.	BT-1	Remember
24.	What are the composition of duralumin?	BT-1	Remember
25.	What are applications of non ferrous alloys?	BT-1	Remember
Q.No.	**PART-B:**	**BT Level**	**Competence**
1.	Discuss the composition, Properties, and typical applications of any four Copper alloys	BT-3	Apply
2.	How will you classify Brasses on the composition of zinc? Explain the properties and applications of the main types of brasses.	BT-3	Apply
3.	Discuss the characteristics of Aluminium and also mention its alloys, their properties and uses.	BT-3	Apply
4.	Choose the composition, properties and uses of bearing alloys.	BT-4	Analyze
5.	What are the properties of aluminium? And what is the effect of different types of alloying elements such as copper, iron, managanese, magnesium used with aluminium and its application? Explain.	BT-3	Apply
6.	Explain age hardening of Al-Cu with the help of phase diagram.	BT-3	Apply
7.	Name non-ferrous materials for the following articles a. Bush b. Furnaces heating element c. Type writer parts d. Coins e. Girders for airship f. Big end bearing g. Filament of electric lamps h. Turbine blades	BT-3	Apply
8.	Explain the composition, properties, and typical applications of some Aluminium alloys.	BT-3	Apply

9.	Explain Ni based super alloys and Ti alloys.	BT-3	Apply
10.	Why copper is a suitable material for automobile radiators? Explain.	BT-3	Apply
11.	What are the outstanding properties of cupronickel alloys? Explain.	BT-3	Apply
12.	With part of phase diagram and relevant graphs, Explain precipitation hardening treatment of AL-CU alloy.	BT-3	Apply
13.	Explain low temperature non ferrous materials.	BT-3	Apply
14.	Explain High temperature non ferrous materials	BT-3	Apply
15.	Explain the composition, properties, and typical applications of Cupronickel.	BT-3	Apply
16.	Explain the composition, properties, and typical applications of Bronze.	BT-3	Apply
17.	Explain the composition, properties, and typical applications of Duralumin.	BT-3	Apply
18.	Explain BIS specification.	BT-3	Apply

UNIT- V / MECHANICAL TESTING AND CHARACTERIZATION

Mechanical properties - stress - strain curve for ferrous and non-ferrous alloys - Mechanism of plastic deformation, slip and twinning – Fracture: types – Griffith theory - Material testing: Tensile, compression and shear loads –Hardness tests: Brinell, Rockwell and Vickers - Impact test: Izod and Charpy - Fatigue and creep tests – fracture toughness tests - Characterization techniques: Optical, SEM, XRD.

Q.No.	**PART-A**	**BT Level**	**Competence**
1.	Define fracture.	BT-1	Remember
2.	What is brittle fracture?	BT-1	Remember
3.	Define ductile fracture.	BT-1	Remember
4.	What is fatigue fracture?	BT-1	Remember
5.	Define creep fracture.	BT-1	Remember
6.	What is the use of tensile test?	BT-1	Remember
7.	State the use of Izod test.	BT-1	Remember
8.	Write the difference between Slip and Twinning.	BT-2	Understand
9.	Define endurance limit in fatigue test.	BT-1	Remember
10.	Differentiate between Fatigue and Creep tests.	BT-2	Understand
11.	Distinguish between elasticity and plasticity.	BT-2	Understand
12.	What are the factors affecting mechanical properties?	BT-1	Remember
13.	How can you prevent the brittle fracture?	BT-2	Understand
14.	Differentiate between ductility and malleability.	BT-2	Understand

15.	Define the terms brittleness and hardness.	BT-1	Remember
16.	What is meant by toughness and stiffness?	BT-1	Remember
17.	What are the factors affecting the creep?	BT-1	Remember
18.	Define the term notch sensitivity.	BT-1	Remember
19.	Define endurance limit.	BT-1	Remember
20.	Differentiate between Brittle fracture and ductile fracture	BT-2	Understand
21.	Define Brinell hardness test.	BT-1	Remember
22.	Define SEM.	BT-1	Remember
23.	Any four Application of XRD.	BT-1	Remember
24.	Define the term stress and strain.	BT-1	Remember
25.	Define Hook's law.	BT-1	Remember
Q.No.	**PART-B:**	**BT Level**	**Competence**
1.	Critically compare the deformation by slip and twinning.	BT-3	Apply
2.	Explain the mechanism of plastic deformation of metals by slip and twinning?	BT-4	Analyze
3.	Explain creep test.	BT-4	Analyze
4.	What are the different types of fractures in metallic materials? Formulate the important features of these fractured surfaces. What is the use of this study?	BT-4	Analyze
5.	Draw a typical creep curve and explain the various stages of creep.	BT-3	Apply
6.	With a neat sketch, explain fatigue test.	BT-3	Apply
7.	Draw the engineering stress – strain curve for mild steel, aluminium and cast iron. Discuss the tensile test and different mechanical properties obtained in tensile testing.	BT-3	Apply
8.	With the help of neat sketches explain brittle fracture.	BT-3	Apply
9.	With the help of neat sketches explain ductile fracture.	BT-3	Apply
10.	Describe Brinell hardness test to determine the hardness of a metal.	BT-3	Apply
11.	Explain the procedure for performing the Rockwell test.	BT-4	Analyze
12.	Explain the testing procedure for Vickers hardness test and mention the advantages and limitations.	BT-3	Apply
13.	Explain Charpy and Izod impact tests	BT-3	Apply

14.	A steel specimen is tested to evaluate several mechanical properties . The dimension of the specimen and observation during the test are given below: Diameter of the specimen =15mm Gauge length = 65mm load at yield point =44KN Maximum Load =78KN Facture load =53KN	BT-3	Apply
	Gauge length at fracture =83mm Diameter of fracture section =10mm Strain at a load 20KN $=8.764X10^{-4}$mm/mm Determine : 1.The yield strength 2. Ultimate Strength 3. % of Elongation 4. Modulus of Elasticity 5.% Reduction in Area 6.Fracture Stress 7.Modulus of Toughness		
15.	Describe how the torsion test is conducted and what are the properties from this test?	BT-3	Apply
16.	Explain the testing procedure for Optical microscope and mention the advantages and limitations.	BT-3	Apply
17.	Explain the testing procedure for scanning electron microscope and mention the advantages and limitations.	BT-3	Apply
18.	Explain the testing procedure for XRD and mention the advantages and limitations.	BT-3	Apply