MECHANICAL DEPARTMENT

ENGINEERING METALLURGY

QUESTION BANK

UNIT- I - ALLOYS AND PHASE DIAGRAMS

PART-A (2 MARKS)

1. What is an alloy?
2. Define solid solution.
3. Differentiate between substitutional and interstitial solid solution
4. State Hume Rothery's rules for formation of substitutional solid solutions. (Or) State the conditions under which two metallic elements will exhibit solid solubility
5. What are intermediate phases?
6. Define 'phase'. What different kinds of phases are possible?
7. What are the advantages of the equilibrium diagrams?
8. State Gibb's phase rule.
9. What is a liquidus line, a solidus line and a solvus line?
10. What is the information that can be obtained from each point in a phase diagram?
11. What is tie-line?
12. Explain the lever-law calculation and what information does it provide?
13. What is meant by invariant reaction?
14. Define the Eutectoid reaction. Give examples.
15. What is eutectic reaction?
16. Distinguish between peritectic and peritectoid reactions.
17. Define: ferrite and austenite.
18. Define: Cementite and Pearlite
19. Define: martensite, and bainite.
20. What is meant by eutectoid, hypoeutectoid, hypereutectoid steels?
21. How do cast irons differ from steels in terms of carbon content?
22. Distinguish between hypoeutectic and hypereutectic cast irons.
23. Define polymorphism and Allotropy.
24. Name the various micro structures of Fe-Fe3C phase diagram.
25. Draw a typical cooing curve of pure metal and a soild solution?
26. What is an equilibrium phase diagram?

PART-B

1. What are cooling curves? Explain the time-temperature cooling curve of a pure metal, binary solid solution and binary eutectic system?
2. Plot and explain with examples (a) a binary phase diagram for two metals which are completely soluble in liquid and solid states.

(b) a phase diagram for binary eutectic alloy system ?

3. What are the micro-constituents of iron-carbon alloys? Explain the general characteristics of each.
4. Draw iron-iron carbide equilibrium diagram and mark all salient temperatures and composition fields and phase reactions involved in it
5. Describe the phase changes that occur when a molten 0.35% C steel solidifies and cools slowly from 1700° C to room temperature. Also draw the probable microstructure of steel at about 800°C and b25 °C.
6. Name the phase reactions occurring in Fe –Fe3C system. What are the temperatures and compositions at which they occur?
7. Explain the primary crystallization of eutectoid steels, hypoeutectoid steels and hypereutectoid steels
8. Explain the primary crystallization of eutectoid cast irons, hypoeutectoid cast irons and hypereutectoid cast irons
9. Two metals A and B have melting points at 900 °C and 800°C .The alloy pair forms an eutectic at 600°C of composition 60% B and and 40%A. A and B have unlimited mutual solubilities. Their solid solubilities are as follows: 10%B in A at 600°C and 5%B in A at 0°C. 12% A in B at 600°C and 4% A in B at 0°C. Assume liquidous, solidous and solvus lines to be straight, no solid state reactions other than solubility changes occur in the series.(i) Draw the phase diagram for series and label all the temperatures,compositions and fields (ii) Find the number, type, extent and composition of the phases present in an alloy of composition 60%A and 40%B at 200 °C ?
10. Two metals A and B have 100% mutual solubilities in the liquid and solid states. The melting point of pure metals A and B are 800°C and 600 °C respectively. Details of start and end of solidifications of various alloys in the series as follows:

Alloy Compositions	Temperature at the start of solidification	Temperature at the end of solidification
90% A +10% B	798°C	750°C
70% A +30% B	785°C	705°C
50% A +50% B	757°C	675°C
30% A +700% B	715°C	645°C
10% A +90% B	650°C	615°C

(i) Draw the phase diagram of the series if there are no solid state reactions and label all the regions. (ii) Determine the number, relative amount and concentration of phases present in an alloy of 40%A and 60% B at 700°C and 400°C?

11. What are called solid solutions? Name the types of solid solutions and briefly explain them.

UNIT- II- HEAT TREATMENT

PART-A (2 MARKS)

1. What are the purposes of the processing heat treatments?
2. Draw the cooling curve for a pure metal and an alloy.
3. List the various stages of a heat treatment process.
4. What is meant by annealing? List the different types of annealing and mention its purpose?
5. What is meant by full annealing?
6. What is meant by process annealing?
7. What is meant by stress relief annealing and spheroidizing ? State its importance.
8. Differentiate between normalizing and full annealing.
9. What is quenching? List some of the quenching medium generally used in industries.
10. What are the factors should be considered while selecting a quenching medium?
11. What are the three stages for quenching?
12. What does the term hardening refer to? What are the factors that affect the hardness?
13. Distinguish the work hardening process with the age hardening process.
14. The tempering process usually follows hardening process. Justify.
15. What is the significance of TTT diagram in the heat treatment of steel?
16. What is CCT diagram?
17. Define the term critical cooling rate (CCR).What are the factors affecting it?
18. What is the difference between hardness and hardenability?
19. What is martempering and austempering?
20. List some of the surface-hardening techniques employed for altering surface chemistry? and Which type of surface hardening process that does not involve composition change?
21. Explain briefly about carbonitriding.
22. What is flame hardening?
23. What is temper embrittlement?
24. Define Recrystallisation ?
25. Name any two shallow hardening process?
26. List the advantages of case hardening.
27. What are the principle advantages of austempering over conventional quenching and temper method.
28. Mention few application of induction hardening system.

PART-B

1. Compare and contrast the different process of Annealing?

2. Explain briefly the various tempering processes. Compare a contrast Austempering and Martempeirng processes?

3. (a) Describe the normalising process of heat treatment?

(b)Differentiate between normalising and full annealing?

4. Explain the Jominy end-quench method of determining hardenability. List the factors affecting Hardenability

5. What do you understand by Isothermal transformation? Draw a eat sketch of the TTT diagram for a eutectoid steel and label the regions. Mark the different products formed on this diagram

6. (a) What is a CCT diagram? (b) Describe various cooling curves on TTT diagrams. How such curves drawn? (c) Write short notes on critical cooling rate? (d)Brief on hardening and tempering of steel w.r.to rate of cooling and tempering temperature respectively?

7. What is meant by Case hardening of steels? Briefly explain the various types of Carburising?

8. Explain the process of nitriding and Cyaniding .List and discuss the advantages of nitriding over carburising?

9. Describe the flame hardening process with the aid of neat sketch .Also brief the advantages, disadvantages and applications of flame hardening?

10. Explain the principle of Induction hardening and compare with flame hardening process?

11. Compare and contrast the process of full annealing, stress relief annealing, recrystallization annealing and spheroidise annealing.

UNIT- III-FERROUS AND NON-FERROUS METALS

PART-A (2 MARKS)

1. What are three primary groups of plain carbon steels?
2. What are the primary effects of chromium, and copper as alloying elements in steel?

Effects of alloying copper: Increases strength, and increases corrosion resistance.

3. What is the effect of alloying Silicon and Cobalt in steels?
4. Which alloy elements are basically a) carbide(stabilizers) formers, and b) graphite stabilizers) promoters?
5. What makes a stainless steel "stainless"?
6. What are the required properties of a tool steel?
7. What is meant by 18-4-1 high speed steel?
8. What are HSLA steels? Where are they used?
9. What are Maraging steels? Give its composition.
10. What are the features that make cast iron an important material?
11. What is the difference between malleable cast iron and ductile cast iron?
12. What are the primary effects of adding Ni, and Mo in cast irons? [
13. List the outstanding properties of copper and some typical applications.
14. What is the main difference between a brass and a bronze.Also List at least four types of brasses used?
15 List some bronze alloys.
16. How do you classify Cast irons?
17. What are gun metals? Give its composition?
18. State the composition, properties and applications of cupronickel and Monel metal.
19. What is Duralumin and mention its applications?
20. What is meant by precipitation hardening?
21. Differentiate between natural ageing and artificial ageing.
22. What are the required characteristics of a bearing material?
23. What are super alloys?
24. What is meant by Babbit metal ? Give its composition and applications.
25. Which type of steel is used for surgical instruments?
26. Name any two copper alloy and its composition.
27. What are the effects of adding Tungsten on steels?

PART-B

1. Describe the properties and typical applications of Low, Medium and high carbon steels?
2. (a)Summaries the effect of the following elements as alloying additions to steels: Mn, Si, Cr, Mo, V, Ti, Al, Si, Cu, W?

   (b) Breif on the influence of alloying elements in steel under classification of carbide former and non carbide former?
3. Describe the different types of stainless steels, making reference to approximate compositions, structures, heat treatments and applications ?
4. Write an engineering brief about (a) Tool steels (b) HSLA steels (c)Maraging steels (d)High speed steels?
5. Describe the structures of main types of Cast iron and explain the factors which affect the structure of Cast iron?
6. Discuss the composition, properties and typical applications of Copper alloys?
7. (a)Explain the composition, properties and typical applications of Aluminium alloys?

   (b) What are the types of titanium alloy, their composition, properties and applications?

   (c) Explain the composition, properties and typical applications of Nickel alloys.
8. Explain the process of Precipitation strengthening treatment for the Al-4%Cu system?
9. a.What are the necessary metallurgical characteristics required in a good bearing metal?

   b.Compare and contrast lead- base, tin-base, copper-base and aluminium-base bearing alloys.
10. What is an alloy steel? How are alloy steels classified. Explain them?

UNIT- IV- NON-METALLIC MATERIALS

PART-A (2 MARKS)

1. What are polymers?
2. What is meant by the term 'unsaturated molecule'? State its significance in plastics.
3. What is polymerisation?
4. Define the term 'degree of polymerisation'?
5. What is the difference between addition polymerisation and condensation polymerisation?
6. Why are additives added to polymers?
7. Name any four commodity plastics and engineering plastics?
8. Distinguish between thermoplastics and thermosetting plastics.
9. Name any four thermoplastics and thermosetting plastics.
10. What are the following 'acronyms' refer to: PE, PP, PS, PVC, PTFE, PMMA?
11. List the properties and typical applications of PVC.
12. What are acrylic materials? Name any two.
13. Write short notes on nylons. & PMMA and its applications?
14. What are bakelites? Also state their applications.
15. List the characteristics of urea-formaldehyde.
16. List some of the distinct characteristics of engineering ceramics.
17. Name any four engineering ceramics. List the applications of Engineering Ceramics?
18. What is meant by PSZ?
19. What are sialons? State their applications. and $Al_2 O_3$?
20. What is the role of matrix material in a composite?
21. List the various matrix materials used.
22. What are cermets? What are two common uses of cermets?
23. What is ABS and state any two of its applications.
24. What is meant by metal matrix composites? Give one example each to matrix material
25. What is Fibre reinforced Plastics? Mention its advantages?
26. Define superconductivity.
27. Differentiate between commodity and engineering polymers.
28. What are the advantages of PTFE polymers?
29. Write short notes on PET.
30. Differentiate between composite and an alloy.

PART-B

1. What is polymerization? Describe addition polymerization and condensation polymerization with examples?
2. (a).Describe the difference between thermoplastics and thermosetting plastics?
   (b).Explain the differences between commodity plastics and Engineering Plastics?
3. What are the properties and application of thermo plastics PVC, PET, PP , PC PMMA, ABS,PEEK PTFE ?
4. What are the properties and application of thermosetting plastics PF, UF, Polyesters, Epoxides, Polyurethanes?
5. Discuss the properties and typical applications of the following engineering Ceramics (i) $Al_2 O_3$ (ii)SiC, (iii) $Si_3 N_4$, (iv) PSZ (v) Sialons
6. Describe the following terms a) Linear polymer b) Branched polymer c) chain stiffening d) Cross linked polymer.
7. **(a)** Classify composite materials and list two properties and application of them?
   (b)Explain the difference in strengthening mechanism between dispersion-strengthened and large-particle reinforced composites?
8. Write short note about the different types of matrix materials and reinforcement materials used to make polymer matrix composite.
9. **(i)** Explain the strengthening mechanism of fibre-reinforced composites?
   (ii) List the advantages, Limitations and applications of composite materials?
10. What are the properties and application of thermo plastics PP, PE, PS, PAN, PA, POM, PC, PPO, PPS, PI, PAI ?
11. With relevant diagram explain the two models of viscoelastic behavior.

UNIT-V- MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS

PART-A (2 MARKS)

1. Distinguish between elasticity and plasticity.
2. Differentiate between ductility and malleability.
3. What do you mean by toughness and stiffness?
4. What is the effect of the grain size on the mechanical properties of the materials?
5. Distinguish between elastic and plastic deformation of solid.
6. Define the terms slip and twinning.
7. State the Schmid's law and write the equation for critically resolved shear stress.
8. What are the causes of twins?
9. List the different types of fracture in a material.
10. State the Griffith's criteria.
11. Distinguish between brittle fracture and ductile fracture.
12. What is meant by fatigue fracture?
13. What is S-N diagram? What is the significance of it?
14. What is meant by super plasticity?
15. What is creep? Draw a typical creep curve and show different creep stages on it.
16. Define endurance limit in a fatigue test.
17. What is meant by fracture toughness?
18. Draw the stress – strain diagram for ductile material.
19. What is meant by Slip plane, Slip direction and Slip system?
20. Define Fatigue. What are the factors affecting fatigue strength?
21. How can you prevent fatigue fracture?
22. What is meant by creep fracture. What are the factors affecting creep?
24. What is the difference between Izod and Charpy impact testing methods?
25. State the advantages of Rockwell hardness testing over other techniques?
26. What is the difference between HRB and HRC scale?
27. Differentiate between ductile and brittle fracture.

PART – B

1. Explain the different types of mechanical properties and mechanism of plastic deformation by slip and twinning.
2. What is brittle fracture? Explain the Griffth's theory on brittle fracture and deduce an expression for the critical stress required to propagate a crack simultaneously in a brittle material?
3. What is meant by ductile fracture? Explain the mechanism of it?
4. Explain the mechanism of fatigue fracture. How can we prevent?
5. (i) Describe a tensile test to determine various tensile properties (ii)Explain the procedure of (i)a compression test (ii) a shear test?
6. List the various types of hardness testing. Write a short note on Rockwell, brinell and Vickers hardness and their significance.
7. Explain and distinguish Izod test and Charpy test to determine the impact strength of a material. Also mention the application of Impact test?
8. Write an engineering brief about the creep test with a typical curve.
9. Sketch and describe the fatigue test .Draw the S-N curve for mild steel and aluminium and explain its features. Explain the procedure used to obtain S-N diagram.
10. Derive an expression for critical resolved shear stress in a material subjected to uniaxial tensile loading?