Degree/Branch: BE Mechanical Engineering **Semester/Year:II /III**

Subject code &Name : ME 3392 Engineering Materials And Metallurgy

Question Bank

UNIT- I / ALLOYS AND PHASE DIAGRAMS

PART- A(2 Marks for each questions)

1. **Write the constitution of austenite**.
   Austenite is a primary solid solution based on γ iron having FCC structure. The maximum solubility of carbon in FCC iron is about 2% at 11400C
2. **Classify plain carbon steel.**
   Low carbon steel – less than 0.25% carbon, Medium carbon steel – 0.25% to 0.60% carbon, High carbon steel – more than 0.60% carbon.
3. **Define Alloy.**
   It is a mixture of two or more metals or a metal and a non metal
4. **What are alloying elements?**
   The element which is present in the largest proportion is called the base metal and all other elements presents are called alloying base elements.
5. **How will you explain peretectic reaction?**
   In peretectic reaction, up on cooling, a solid and a liquid phase transform isothermally and reversibly to a solid phase having a different composition. Liquid + Solid1== solid2
6. **What is steel?**
   Steel is a composition unto 0.008% carbon is regarded as commercially pure iron those from 0.008-2% Carbon represent the steel.
7. **State the condition for Gibb's phase rule.**
   Pressure variable is kept constant at one atmosphere Gibb phase rule F=c-p+2; F=c-p+1(condensed Gibb phase rule).
8. **Explain base metal.**
   The element which present in the largest proportion is called the base metal
9. **Differential between substitution and interstitial solid solutions.**
   When the solute (Impurities) substitutes for parent solvent atoms in a crystal lattice, they are called substitution atoms, and the manure of the two elements is called a substitution solid solution.
10. **What are alloying elements?**
    In an alloy, all elements other than the base metal are called the alloying elements.

11. **Substitutional and interstitial solid solutions-Differentiate.**
    In a substitutional solid solution, the solute atoms substitute for parent solvent atoms• in a crystal lattice. In interstitial solid solution, the solute atoms fit into the space between the solvent or• parent atoms.
12. **What are inter metallic compounds?**
    The compounds formed by two or more metals in apparently stoichiometric proportion is called inter metallic compounds
13. **Explain the effects of crystal structure and atomic radii on formation of solid solution between two metallic elements.**
    Hume Rothery's Rules Crystal structure: The two metallic elements that form solid solution must have the• same crystal structure. Otherwise, there is some point at which a transition occurs from one phase to a second phase with a different structure. Atomic radii: The solute and solvent elements atoms must be of similar size, with less• than a 15% difference in atomic radius.
14. **Define the term "ferrite" and "austenite" in iron – carbon alloy system.**
    Ferrite is primary solid solution based on α iron having BCC structure. Austenite is a primary solid solution based on γ iron having FCC structure. Both are interstitial solid solutions of carbon in iron.
15. **Explain "allotropy of iron"**
    Allotropy refers to the possibility of existence of two or more different crystal structure for a substance depending upon temperature.
16. **Why carbon solubility is more in an austenite?**
    Austenite is a primary solid solution based on γ iron having FCC structure. Carbon solubility is more in austenite is an interstitial solid structure of carbon in iron.
17. **Distinguish between hypoeutectic and hypereutectic cast irons.**
    Cast irons that contain less than 4.3 % carbon are termed as hypoeutectic whereas cast iron that contains more than 4.3 % carbon is termed as hypereutectic cast irons.
18. **State Gibb's phase rule.**
    Gibb's phase rule is given by F= C – P + 2, Where, F – Degrees of freedom of system or the no. of variables that may be changed independently without altering the equilibrium, C – No. of components forming the system, P – Number of phases present in the system
19. **What are intermediate phases?**
    If an alloying element is added in excess of the limit of solid solubility, a second phase appears along with the primary solution. If the second phase is differs in both crystal structure and properties from primary solid solution, than it is known as an intermediate phases.
20. **How do cast irons differ from steels in terms of carbon content?**

    Composition from 0.008 to 2% carbon represent steel and those above 2% carbon represent cast iron
21. **Write the Hume-Rothery rules for substitutional solid solutions (or) State the conditions under which two metallic will exhibit unlimited solid solubility.**
    Hume – Rothery rules govern the formation of sustitutional solid solutions. 1. Crystal Structure factor The crystal lattice structure of the two elements (metal) should be same for complete solubility; otherwise the two solutions would not merge into each other. Also, for complete solid solubility the size factor must usually be less than 8 %. 2. Relative size Factor If two metals are to exhibit extensive solid solubility in each other it is essential that their atomic diameters shall be fairly similar. 3. Chemical affinity Factor The greater the chemical affinity of two metals, the

more restricted is their solid solubility. When their chemical affinity is great, two metals tend to form an intermediate phase rather than a solid solution. 4. Relative Valence factor The metal of high valence can dissolve only a small amount of a lower valence metal, while the lower valence metal may have good solubility for the higher valence metal

22. What is the significance of phase diagram? (or) What is the information which can be obtained from phase diagram?

To show what phases are present at different at different compositions and• temperatures under equilibrium conditions. To indicate the equilibrium solid solubility of one element in anotherTo indicate the temperature at which an alloy cooled under equilibrium• conditions starts to solidify and the temperature range over which solidification occurs. To indicate the temperature at which different phases start to melt.•

23. Explain phase or equilibrium diagram.

A phase diagram is a graphical method of showing the phases present in an alloy system at different temperatures and different compositions.

24. How cast iron differ from steel?

Cast Iron Steel Ferrous with more than 2% of carbon Ferrous with less than 2% of carbon Is a brittle and tough metal Is a ductile metal

25. What is Allotropy?

The possibility of existence of two or more different crystal structures for a substance is known as allotropy. Steel is the best example for the allotropy.

26. State the three classes of plain carbon steel.

1. Hypo- Eutectiod steel: These have carbon contents varying from 0.008% to just below 0.83%. 2. Eutectiod Steels: These have carbon content idly 0.83% 3. Hyper- eutectoid steel: These have carbon content varying from 0.83% to 1.8%.

27. Explain interstitial Solid Solution.

Solute atoms of smaller atomic diameters like Hydrogen, Carbon, Nitrogen, and Boron can occupy the empty spaces (interstices) in the crystal lattices of many metals. This type of solutions in the solid state is called as interstitial solid solution Eg: Carbon in iron forms steel

28. Define Isomorphous.

The possibility of existence of two or more different crystal structures for a substance is known as allotropy.

29. What is Invarient Reaction?

Give an Example. Reaction in the solid solution in which the equilibrium may exists only under entirely definite conditions; at a constant temperature and at a definite composition of all phases involved.

30. Define Eutectic Reaction. Give an example.

When two metals are completely soluble in the solid state, it is called as eutectic reaction.Iron-carbon, aluminum– manganese, lead- tin, copper- nickel form an eutectic solution.

31. Write the Classification of steel.

I. Plain Carbon steels Low carbon Steel (Mild steel) – Carbon upto 0.25% C Medium carbon steel - 0.25 to 0.55% C High Carbon Steel (Tool Steel) - 0.6 to 1.5 % C II. Alloys steels Low alloy Steels - Alloying Elements upto 5% Medium alloy Steels - Alloying elements 5 – 10 % High alloy Steels - more than 10% of alloys.

32. What is peritectic Reaction?

Write an example for that reaction. Liquid and solid combines and form a new solid. The melting point of two metals differs considerably. Silver and platinum form such a system. Liquid + Solid New Solid

33. Write the different Classes of cast iron

Type % of C % of Si % of Mn % of P % of S Grey cast iron 2.5 – 3.8 1.1 – .8 0.4 – 1 0.15 0.10 White cast iron 2.0 – 2.3 0.85-1.2 0.10 – 0.40 0.05 – 0.2 0.12 – 0.35 Nodular cast iron 3.2- 4.2 1.1 – 3.5 0.3 – 0.8 0.08 0.2 Meallable cast iron 2-3 0.6 – 1.3 0.2 – 0.6 0.15 0.10 34. What is Eutectoid Reactions? Write an example of the eutectoid reaction occurs in the Iron Carbon System This reaction is due to the transformation in solid state. Austenite à Ferrite + Cementite

PART-B(16 Mark Questions)

1. What are cooling curves? How does the time-temperature cooling curve of an alloy of eutectic composition differ from that of a pure metal that of a non–eutectic composition alloy?

2. How will you plot binary phase diagram for two metals which are completely soluble in liquid and solid states?

3. Explain the following invariant reactions with reference to a phase diagram (a) eutectic reaction (b) eutectoid reaction (c) Peretectic reaction (d) Peretectoid reaction.

4. What is the micro constituent of iron carbon alloys? Explain the general characteristics of each?

5. Draw Iron-iron carbide equilibrium diagram and mark on it all salient temperatures and composition fields.

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 hypo-eutectoid steels and hypereutectoid steels.

8. Define the primary crystallization of eutectic cast irons hypoeutectic cast irons and hypoeutectic cast iron with the help of neat sketch.

9. Explain in brief the properties and applications of cast Iron types.

10. Draw Fe-C diagram and mark all the phases and explain the reactions?

11. Explain the types of cast iron? Draw the microstructure of any four types of cast iron?

12. Brief Isomorphous phase diagram for Cu-Ni system and Ideal phase diagram (soluble and insoluble)

13. Explain Hume Rothery rule?

14. Explain the different types of carbon steel?