ME3392 ENGINEERING METALLURGY

QUESTION BANK

UNIT- I
ALLOYS AND PHASE DIAGRAMS

1. **What is bainite and Martensite?**
   I. Bainite is the microstructure produced in steel when austenite transforms at a temperature below that at which pearlite is formed and above that at which martensite is formed. Bainite is a decomposition product of austenite consisting of ferrite and cementite.
   II. Martensite is a meta stable phase of steel formed by transformation of austenite below the M_S temperature. Martensite is a highly stressed α - iron which is super – saturated with carbon.
2. **Define Solid Solution.**
   - A solid solution is one in which that complete intermingling of the atoms of both metals which prevail in the liquid solution is retained in the solid state
3. **Distinguish between steel and cast iron. Also classify steels with respect to carbon percentage.**
   1. In steels, the carbon is present in the combined form as Cementite (Iron Carbide).
   2. In cast iron, carbon is present in free form as graphite.
   3. With respect to *Carbon percentage*, steels are classified as
      - Hypoeutectoid steels (0 to 0.8%C),
      - Eutectoid steels (0.8% C)
      - Hypereutectoid steels (0.8% to 2.0%C).
4. **Define an alloy.**
   - An alloy can be defined as a metallic solid or liquid consisting of an intimate association of two or more elements. The elements concerned mingle together on the atomic scale.
5. **What is a binary isomorphous alloy system?**
   - The simplest binary phase diagram is for a system exhibiting complete liquid solubility as well as solid solubility such a system is called a binary isomorphous system. To indicate that the crystal structures of the two components and the solid solution are the same.
6. **What are the three primary variables considered in equilibrium diagrams.**
   The primary variables considered in equilibrium diagrams are
   1. Temperature
   2. Pressure
   3. Composition
7. **State the condition favourable for formationof solid solution.**
   - A solid solution is readily formed if the elements concerned are soluble in the molten state as well as solid state, i.e, they form a single homogeneous solution.
8. **What is a phase mixture?**
   - In a situation where the attraction between unlike atoms is weaker than the attraction between like atoms, the like atoms tends to separate into different crystals which meet at

a mutual garin boundary. A heterogeneous mixture of this type is called a phase mixture.

9. What is coring?

- As an alloy solidifies, the core of the crystal will contain more atoms of the metal of higher melting point whilst the outer fringes and boundary regions will contain a larger proportion of atoms of the metal of lower melting point. This difference in composition between the core of the crystal and its boundary regions is referred to as coring.

10. How are the phase diagrams classified?

- Phase diagrams are classified as
  - Unary (or One-Component) phase diagrams
  - Binary (or Two-Component) phase diagrams
  - Ternary (or Three-Component) phase diagarms

11. What is an invariant reaction? Give examples.

- An invariant reaction is called so because they occur under the condition when the degrees of freedom is zero.
- **Examples:** Eutectic, Eutectoid, Peritectic and Peritectoid reactions

12. What are the allotropic forms of iron?

- Iron exists in three allotropic forms, namely
  - α - iron (BCC crystal structure)
  - γ - iron (FCC crystal structure)
  - δ - iron (BCC crystsl structure)

13. State the lever rule.

- The relative amounts of the co-existing phases at a specified temperature is given by the lever rule. The tie – line is taken to be the lever arm with the fulcrum at the overall composition.
- For example, the fraction of liquid $\mathbf{f}_l$ for the overall composition $\mathbf{C_o}$ is given by,

$$\mathbf{f}_l = \frac{\mathbf{C_s} - \mathbf{C_o}}{\mathbf{C_s} - \mathbf{C_L}}$$

Where

$\mathbf{C_s}$ is the composition of solid phase $\mathbf{C_L}$ is the composition of liquid phase

14. Give a list of the microstructures of steels and cast irons.

1. Austenite
2. Bainite
3. Ferrite
4. Ledeburite
5. Pearlite
6. Martensite
7. Troostite
8. Sorbite

15. What is ledeburite?

1. Ledeburite is the eutectic mixture of austenite and cementite.
2. It contain 4.3% Carbon
3. It is formed at about 1130^{o}C.

16. What is pearlite?

- The pearlite microstructure consists of alternate lamellae of ferrite and cementite.
- Pearlite is the product of austenite decomposition by an eutectoid reaction.
- Peralite is an eutectoid mixture containing about 0.8% Carbon and is formed at 727^{o}C.

17. What is a tie-line used for?

- A tie-line is used for determining the composition of individual phases.
- A horizondalline (called a tie-line or an isotherm) is drawn at a specified temperature .
- The intersection of this line with the liquidus line gives the liquid composition.
- The intersection of this line with the solidus line gives the solid composition.

Part B

1. i)Explain briefly Isomorphous phase diagram for Cu-Ni system and Ideal phase diagram (soluble and insoluble) i)How are solid solutions classified? Give example for each.

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

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

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

5. Name the phase reactions occurring in Fe-Fe3C system. What are the temperatures and compositions at which they occur?

6. Explain the primary crystallization of eutectoid steels, hypoeutectoid steels and hypereutectoid steels.

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

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

UNIT- II

HEAT TREATMENT

1. **Define heat treatement.**
   - Heat treatment is an operation or a combination of operations involving heating and cooling of a metal or alloy in solid state to obtain desirable conditions. (**E.g.** to relieve residual stresses) or to obtain desirable properties (**E.g.** better machinability, improved ductility, or homogeneous structure)
2. **Name the various methods of heat treatment.**
   - Annealing
     - Stress relief annealing
     - Process annealing
     - Recrystallization annealing
     - Spheroidize annealing
     - Full annealing
   - Normalising
   - Hardening
   - Tempering
   - Martempering
   - Austempering
3. **Define full annealing.**
   - Full annealing implies annealing a ferrous alloy by austenitizing (i.e, heating to a temperature that is above $\mathbf{A_3}$or $\mathbf{A_{cm}}$line) and then cooling slowly (in the furnace itself) through transformation range.
4. **What are tha purposes of full annealing?**

   The purpose of full annealing is to
   - Refine grain size.
   - Removes strains from forgings and castings.
   - Increase softness
   - Improve machinability
   - Improve electrical and magnetic properties.
5. **What is the use of isothermal transformation (IT) diagram?**
   - An isothermal transformation diagram shows the relationship between temperature and time taken for decomposition transformation to take place in a metal, when the transformation is isothermal i.e., at constant temperature.
   - It is used more particularly in the assessment of decomposition of austenite in a heat treatable steel.
6. **Differentiate between stress - relief annealing and recrystallization annealing.**

S.No.	Stress - relief annealing	Recrystallization annealing
1.	This is used to relieve residual stresses due to Cold working, forming or machining operation	This is used to decrease hardness or strength and to increase ductility of cold worked steel.
2.	This is employed as a final heat treatment	This is used both as intermediate operation and as a final treatment

7. **Why is it necessary to temper hardened steel?**
   - The martensite formed in hardened steel is extremely brittle, hard and highly stressed. The hardened steel besides has some retained austenite also, which is unstable at room temperature.
   - It is therefore necessary to return to equilibrium by heating the hardened steel to a temperature below the lower critical temperature ($\mathbf{A_1}$) which is tempering.

8. **Define hardenability and case depth.**

   Hardenability: Hardenability is the ease with hardness may be obtained in the depth direction of an object. It may also be called as the ability of a steel to uniformly harden in the depth direction.

   Case Depth: Case depth is defined as the perpendicular distance from the surface of the steel to the point at which the change in hardness, chemical composition or microstructure of the case and core cannot be distinguished.

9. **Write the importance of spheroidize annealing.**
   - Spheroidizing is a heat treatment process which results in a structure consisting of globules or spheroids of carbide in a matrix of ferrite.
   - A steel with lamellar carbide is much harder than that has spheroidal carbide. So, spheroidizing improves both machinability and facilitates a subsequent cold working operation.

10. **What are the different processes of surface hardening?**
    1. Carburizing
    2. Cyaniding
    3. Nitriding
    4. Carbonitriding
    5. Flame hardening
    6. Induction hardening
    7. Vacuum hardening
    8. Plasma hardening

11. **What is quenching? List some of the quenching mediums generally used in industries.**
    - Quenching is a process of rapid cooling of steel from austenitizing temperature quenching is done by allowing the steel to come in contact with some medium which can absorb heat within a short period. Some of the quenching mediums generally used in industries are
      - 5 to 10% caustic Soda
      - 5 to 20% brine solution
      - Cold or warm water
      - Mineral, animal or vegetable oils.

12. **What is the significance of TTT diagram in the heat treatment of steel?**
    - The TTT diagram are significant in the heat treatment of steel. This is due to the reason that these diagrams are extremely useful as they give information about the hardening response of steels and the nature of transformed products of austenite at varying degrees of super cooling.

13. **Define critical cooling rate (CCR).**

- Critical cooling is that slowest rate of cooling at which all the austenite is transformed into 100% martensite.

14. List any two factors that affect hardenability of steels.

- The composition of steel and method of manufacture.
- The quenching media and the method of quenching.
- The size of austenite grains before quenching.
- The homogeneity of austenite before quenching.
- The presence of undissolved carbides and non – metallic inclusions before quenching.

15. Define tempering

- A process which consists of heating hardened steel below the lower critical temperature, followed by cooling in air or at any other desired rate is known as tempering.

16. What is spheroidizing?

- Spheroidizing is a heat treatment process which results in a structure consisting of globules or spheroids of carbide in a matrix of ferrite.
- In other words, Cementite of lamellar pearlite in the case of hypoeutectoid steels and eutectoid steels and both lamellar and free cementite in the case of hyper eutectoid steels, coalesce into tiny spheroids.

17. Explain the term "induction hardening"

- The process of heating medium carbon steels by means of an alternating magnetic field to a temperature within or above the transformation range (i.e., about 750 to 800^{o}C) and follwed immediately by quenching is called induction hardening.

18. What is austempering?

- Austempering is a special heat treatment process in which austenite is transformed into bainite.
- In this process the steel is quenched in a both maintained at a constant temperature above $\mathbf{M_S}$ point and within that bainiticrange (200 to 400^{o}C, in general).
- The steel is maintained at a constant temperature in the bath itself till all the austenite is transformed into bainite.

19. What is martempering?

- Martempering is a heat treatment process to produce martensite with a minimum of stresses, distortion and cracking.
- This is done by quenching steel in a salt bath maintained at a temperature above the $\mathbf{M_S}$ point and is held at this point until the temperature is uniform across the section of workpiece without transformation of austenite.
- It is then cooled in air through the martensitic range.

20. Define normalising.

- Normalising or air quenching consists of heating steel to about 40-50^{o}C above its upper critical temperature
  (i.e., $\mathbf{A_3}$ and $\mathbf{A_{cm}}$line and then cooling in still air at room temperature.

21. What is the purpose of normalising?

- To produce a uniform or homogeneous structure
- To refine the grain size of steel
- To reduce residual stresses
- To produce a harder and stronger steel than full annealing

22. Distinguish between hardness and hardenability.

- Hardness is a measure of resistance to plastic deformation, either by indentation or scratching.
- Hardenability is the ease with hardness may be attained in the depth direction of an object.

23. What is carburizing?

- Carburizing is a method of introducing carbon into solid iron - base alloys such as low carbon steels in order to produce a hard case (surface).
- Carburizing is also called as Cementation.

24. What are the three methods of carburizing commonly employed?

The three methods of carburizing commonly employed are

- Pack Carburizing using solid carburizing medium
- Gas carburizing using suitable hydro carbon gases
- Liquid carburizing using fused baths of carburizing salts

25. Name the four different methods used for flame hardening?

- **Stationery:**Both workpiece and torch are stationery.
- **Progressive:** Torch moves over stationery workpiece.
- **Spinning:** Torch is stationery while the workpiece rotates.
- **Progressive Spinning:** Torch moves over a rotating workpiece.

26. What is nitriding?

- Nitriding is the process of introducing nitrogen into the surface of certain types of steel (E.g : those containing **Al** and **Cr**) by heating it and holding it at a suitable temperature in contact with partially dissociated ammonia or other suitable medium.

27. What are the advantages of carbonitriding over carburizing?

- Nitrogen is more effective in increasing hardenability of the case as compared to carbon.
- Carbonitriding results in better surface hardenability, wear resistance and corrosion resistance than those in carburizing.

28. Define cyaniding.

- In cyaniding, carbon and nitrogen are introduced into the surface of steel by heating it to a suitable temperature and holding it in contact with molten cyanide to form a thin skin case which is subsequently quench hardened.

29. What is vacuum hardening?

1. Vacuum hardening is an improvement over conventional hardening in that the components surfaces are protected from possible negative effects of exposure to a gaseous atmosphere.
2. Vacuum treated steel is quenched in gas or liquid, depending on the specification requiremennts.
3. It should also be noted that hardening is usually referred to as quenching.

30. What is plasma hardening?

1. Plasma hardening or ion hardening is a method of surface hardening using glow discharge technology to introduce nascent (elemental) carbon or nitrogen or both to the surface of a metal part for subsequent diffusion into the material.
2. In a vacuum, high voltage electricity is used to form plasma, through which Carbon/Nitrogen ions are accelerated to impinge on the workpiece.

3. Plasma or ion hardening provides better control of case chemistry and uniform case depth.

Part B

1. Draw a neat sketch of the TTT diagram for eutectoid steel and label the regions. Mark the different products formed on this diagram

2. What is a CCT diagram? Describe various cooling curves on CCT diagrams. How such curves are drawn? Write short notes on critical cooling rate

3. Explain how Jominy end quench test is used for determining the hardenability of steels

4. Brief about tempering process and explain CCT diagram.

5. Define the types of annealing Process and explain them?

6. What is meant by carburizing of steels? Briefly explain the various types of carburizing

7. Enumerate Martempering and Austempering

UNIT- III
FERROUS AND NON-FERROUS METALS

1. What are super alloys?

Supetr alloys are important in high tempwrature application
Their major applications are jet engines, gasturbines, rocket engines, dies in hotworking of metal and nuclear power plant.
It has high strength, creep resistance, erosion, resistance, mechanical and thermal fatigue resistance

2. What are the primary effects of chromium and copper as alloying elements in steel?

CHROMIUM – **Increases the corrosion and oxidation resistance**

Increases hardenability

Resists abrasion

COPPER - **Increases strength**

Increases corrosion resistance

3. What is the effect of alloying Nickel and Tungsten in steel?

NICKEL - **Increases hardenability**

Improves resisitance to fatigue

Strengthen annealed steels

TUNGESTEN-Forms hard abrasion resistant

Promotes red hardness

Raises the softening temperature

4. Define precipitation hardening.

Precipitation hardening also known as agehardening

It is the method of improving the physical properties of some the non-ferrous alloys

- **The fine precipitate particles of the new phase are formed in this hardening process**

5. Define dispersion strengthening.

Particle – Matrix interactions that lead to strengthening occur on the atomic or molecular level.

The plastic deformation is restricted which results in improved yield and tensile strength as well as hardness.

6. Give the composition of the following non – ferrous alloys (a) Gunmetal (b) Babbit metal

Gunmetal: Composition - 88% Cu, 10%Sn, 2%Zn, 2%Ni

Application – For pump values, Mainly for marine works

Babbit metal: Tin based bearing alloys are often called Babbit metals

Composition – 3.5 to 15% antimony, 3.5% copper

7. What are the effects of alloying elements on steel?

The effects of alloying elements on steel is

To increase strength,

To increase hardness,

To increase toughness,

To increase wear resistance

8. How stainless steel are classified?

Stainless steel are classified in to

a. Martensitic stainless steel,
b. Ferritic stainless steel,
c. Austenitic stainless steel

9. What are the types of bronze?

The types of bronze are

a. Phosphorous bronze,
b. Silicon bronze,
c. Bertillium bronze,
d. Manganese bronze,
e. Aluminium bronze.

10**. Define austenite**.

This is an interstitial solid solution of carbon in FCC gamma iron. The solid solubility of carbon in austenite is a maximum of 2.08% at 1147°C
The carbon content is decreases to 0.8% at 723°C
It is soft, ductile and malleable phase.

11. Define Cementite.

The intermetalic compound iron carbide is called cementite.

This compound has a fixed carbon content of 6.67% C

It is an extremely hard and brittle compound

12. Why are aluminium and its alloys more ductile than the magnesium and its alloys?

Plastic deformation depends on number of slip system in a metal

As aluminium and its alloy have more slip systems than magnesium and its alloys they are more ductile.

13. What are the criteria for selection of materials?

The criteria for selection of materials are

a. Availability of materials
b. Properties of materials
c. Cost of materials

14. What are the advantages and limitations of water hardening tool steels?

The advantage are their high hardness, good machinability and low cost

These steels must be quenched in water to attain high hardness and therefore considerable distortion of the tool may occur and they cannot withstand at sever conditions.

15. What is ment by 'non-defering' tool steels?

In cold work tool steels, the chemical composition and hardening heat treatment are adjusted to minimize the distortion after heat treatment.

So, these steels are termed as non-deforming tool steels.

16. What are the three types of hot work tool steel?

Depending upon the principal alloying element hot work is classified as

1. Chromium type

2.Tungsten type

3.Molybdenum type.

17. What are high speed steel and name the two types?

High speed steels are the steel used to make cutting tools, Employed in high cutting speeds

The two types are, (1) Tungsten base HSS, (2) Molybdenum base HSS

18. Define HSLA steel?

It is a high strength low alloy (HSLA) steel

It has higher mechanical property

It has greater resistance to atmospheric corrosion

It is obtained from conventional carbon steel.

19. What are the various mechanism used in HSLA steel to acheive high strength levels?

The various mechanism used in HSLA steel is

i. Grain refinement,
ii. Precipitation of carbides,
iii. Solid solution strengthening of ferrite,
iv. Inclusion shape control,
v. Deoxidation,
vi. Controlled rolling

20. What is white castiron and why is it called so?

In white castiron all the carbon is combined form i.e, in the form of cementite and there is no free carbon

The fractured surface of this type of casting appears white because of the absence of free graphite and hence it is called as white castiron.

21. What is the dominant mechanical property of white cast iron?

White cast iron has high hardness

Wear resistance

It is extremely brittle and difficult to machine

22. What is gray cast iron? Why it is called so?

In this cast iron most of the carbon present in the form of free graphite flakes

The fractured surface appears free because of the presence of graphite flakes and hence it is called grey cast iron.

23. What are the effects of graphite flakes on grey cast iron?

The graphite flakes interrupt the continuity of matrix and they act as voids in the structure

Because of this, grey cast irons are weak in tension.

Moreover, the sharp edges of the flakes act as notches and make the material brittle in nature.

24. What is gilding metal and what are some of its applications?

It is a yellow alpha-brass

It contains 70% Cu and 30% Zn

It is used to make cartridge cases and radiator cores and tanks

It is used to make flash light shells and lamp fixtures

25. **Classify bronzes**

Bronzes are classified as

(1) Tin bronzes,

(2) Aluminium bronzes,

(3) Silicon bronzes,

(4) Berylliuym bronzes

Part B

1. Discuss the influence of various alloying element addition in steels

2. Discuss the composition, properties, application- Maraging steels, Tool steel ,HSLA

3. Discuss the composition, properties and typical application of any four copper alloys.

4. Explain the composition properties and typical application of some aluminium alloy?

5. Write short notes about the following materials in terms of composition properties and application (i) Maraging Steel (ii) Austenitic Stainless Steel (iii)Alpha Beta Brass

6. Explain Ni based super alloys and Ti alloys .

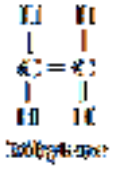
7. What is an alloy steel? How are alloy steels classified? Explain them.

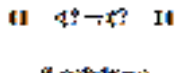
8. Explain the steps involved in precipitation hardening?

UNIT- IV

NON-METALLIC MATERIALS

1. **What is meant by the term unsaturated molecule? State its significance in plastics. (May/June 2014)**
   - ❖ In double and triple covalent bonds molecules, each carbon atom is not bonded to the maximum other atoms. So these compounds are termed as unsaturated.
   - ❖ Its significance in plastics





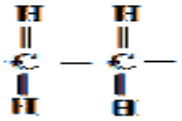
2. **What are sialons? State their applications. (May/June 2014)**
   - ❖ Sialon exhibit a unique combination of fracture toughness , hardness and strength.
   - ❖ A sialon is a ceramic material having the chemical formula $Si_3 Al_3 O_3 N_5$.
   - ❖ **Applications:**
     - ➢ Racing car seals
     - ➢ Cutting tool for steel and non-ferrous metals
3. **Define degree of polymerisation? (May/June 2012)**
   - ❖ The number of monomers which link up to form a polymer is usually referred to as the degree of polymerization.
   - ❖ In otherwords, the count of monomers in a polymer molecule is termed the degree of polymerization.
4. **What are PEEK and PMMA? (May/June 2012)**
   - ❖ PEEK stands for polyether ether ketone and PMMA for thermoplastics used in industrial application i.e., these are engineering polymers.
5. **Name the plastics used for the following applications. (Nov/Dec 2011)**
   (a) Tooth brush (b) Gears
   - ❖ Tooth brush – poly propylene
   - ❖ Gears – Polyamides (Nylon)
6. **What is polymerization? (Nov/Dec 2011)**
   - ❖ Polymerization may be defined as the process of growing large molecules from smallones. Polymerization links together monomers.
7. **Distinguish between polymer and ceramic. (Nov/Dec 2010)**

Polymer	Ceramics
Poor resistance to abrasion	High resistance to abrastion and wear
Low strength at high temperature	High strength at high temperature

8. **What are PMMA and PTFE? (Nov/Dec 2010)**
   - ❖ **PMMA** : Stands for *Polymethyl Methacrylate*
     - ➢ It is a thermoplastic.
     - ➢ It is highly transparent to light.
     - ➢ It has excellent decorative properites.

- **PTFE** : Stands for *Polytetrafluoro ethylene*
  - It is a thermoplastic.
  - It has low coefficient of friction.
  - It is chemically inert is almost all environments.

9. What is the structure of polyethylene? Suggest any two uses. (Apr/May 2011)



Applications:

- Flexible bottles, toys, packingflims, seals and gaskets.

10. Brief about any two types of polymers? (Nov/Dec 2013)

- **Polyethylene:** Used as packing flims, wire insulation squeeze bottles.
- **Polystyrene:** Used for low-cost transparent moulding such as CD cases, ball-point pens, food boxes, lighting panels.

11. Mention any four attractive properties of engineering ceramics. (Apr/May 2010)

- High resistance to abrasion and wear.
- High strength at high temperature.
- Good chemical stability.
- Good electrical insulation characteristics.

12. Distinguish polymer and ceramic with respect to mechanical and physical properties. (Nov/Dec 2010)

Property	Polymers	Ceramics
Mechanical		
→ Tensile strength	30 max	100 max
→ Field strength	25 max	Does not yield
→ Elongation	Can be 100%	Zero
Physical		
→ Density	0.03 to 0.1	0.1 to 0.6
→ Melting point	< 500°C	> 5000°C
→ Coefficient of thermal expansion	Very high	Low

13. What is PET polymers? What are its uses? (Apr/May 2010)

- **PET :*(polyethylene terephthalate)*** is also known as polyster or PETP, is a linear polyster made by the condensation polymerization of ethylene glycol and terapthalic acid.
- **Applications :**Typical applications of PET include fibers, photographic films, recording tapes, boil-in-bag containers, beverage containers, soft drink bottles.

14. State any two properties of ceramics. (Nov/Dec 2009)

- High resistance to abrasion and wear
- High strength at high temperature

15. With property and application explain following polymers (May/June 2009)
(a) PVC (b) PMMA

a) PVC – *Poly Vinyl Chloride* **Properties**	**b) PMMA – *Poly Methyl Methacrylate*** **Properties**

❖ It is rigid but can be made ❖ Flexible with plasticizers **Applications** ❖ Pipes, valves, fittings, floor tiles, safety glass	❖ Hard, rigid and high impact strength ❖ Highly transparent to light **Applications** ❖ Camera lenses, Flash lights, Drafting equipments

16. How are refractories classified? (Apr/May 2008)

- ❖ Fine clay refractories
- ❖ Silica refractories
- ❖ Basic refractories
- ❖ Special refractories

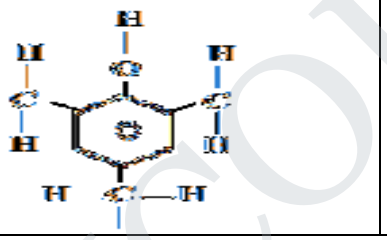
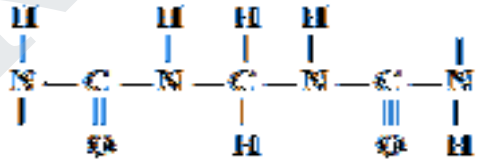
17. What do you mean be Copolymers? (Apr/May 2008)

- ❖ Copolymers are polymers which are obtained bby adding different type of monomers.

18. Name any four common engineering polymers. (Nov/Dec 2007)

- ❖ Ethenic
- ❖ Polyamides
- ❖ Silicones
- ❖ Polyimides

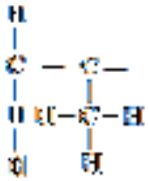
19. Write the molecular structure of either Phenol – Formaldehyde (PF) polymer or Urea – Formaldehyde (UF) polymer. (May/June 2007)

Phenol – Formaldehyde (PF)	Urea – Formaldehyde (UF)
	

20. Give two examples of particulate reinforced metal matrix composites. (May/June 2007)

- ❖ Sintered aluminium powder (**HI / Al_2O_3**)
- ❖ Cermet

21. Draw the molecular structure of polyethylene and polypropylene. (Nov/Dec 2006)

Polyethylene	Polypropylene
	

22. Give the example each for metal – matrix composites and ceramic – matrix composites. (Nov/Dec 2006)

- ❖ Examples of metal – matrix composites : ***Ag – Cdo,*** ***Al – Al_2O_3***
- ❖ Examples of Ceramic matrix composites :*Tunsten carbide, Aluminium oxide, Titanium boride.*

23. Name four ethnic polymers (Polymers that have the basic monomer structure of ethylene) (May/June 2006)

- ❖ Polypropylene (PP)

- Polyethylene (PE)
- Poly vinyl chloride (PVC)
- Polystyrene (PS)

24. What are the important uses of alumina and silica nitride? (May/June 2006)

- Aluminium ceramics are used for any type of load bearing application.
- They are used for Rocket nozzles, Pump impellers
- Silicon nitrides are widely used as cutting tool materials.

25. What is the role of matrix in a composite?

- The usually provides the major control over electrical properties, chemical behavior and elevated – temperature use of composite.

26. List out various matrix materials used.

- **Thermosetting resins :**Polyster resins, Epoxide resins
- **Thermoplastics :**PA,PAI, PBT, PET, PES, PPS, PEEK
- **Metal matrices :** Al, Ti, Mg, Cr and Ni
- **Composite matrices**

27. List the various fibre materials used in the Fibre – reinforced composites.

- **Polymers :** Kevlar, nylon, polyethylene
- **Metals :** Be, Boron
- **Glass :** E – glass, S - glass
- **Carbon : HS** (High strength), **HM** (High Modulus)

28. What are Cermets?

- The term 'Cermet' refer to Ceramic – metal composite containing 80 to 90% of ceramics.
- Cermets are composed of ceramic particles in a metallic matrix.
- **Applications :**Cutting tools, Slip gauge, wire drawing dies, rocket motor.

29. List the characteristics of Urea – Formaldehyde.

- They are similar to the phenolics.
- They are hard and rigid thermosets.
- Good electrical insulation properties.
- Good resistance to most chemicals.

30. What are bakelites?

- Phenolics, also known as bakelites, are the oldest family of thermosetting plastics.
- The most important phenolic materials are *polyformaldehydes.*
- **Applications :**Electrical plugs, sockets, switches, telephones and door knobs.

31. What are acrylic materials? Name two of them.

- Acrylic materials are thermoplastic polymers based on the polymerization of esters of acrylic acid or methacrylic acid
  - PMMA
  - PAN

32. What are the additives added to polymers?

- Filler materials
- Plasticizers
- Stabilizers
- Colorants
- Flame retardants

- Reinforcements
- Lubricants

33. Why are the fillers and plasticizers added to polymers?

- **Fillers**
  - To improve tensile and compressive strength
  - To improve dimensional and thermal stability
- **Plasticizers**
  - To improve the flexibility and ductility
  - To reduce the hardness and stiffness

Part B

1. What is polymerization? Describe addition polymerization and condensation polymerization.

2. Explain about the flowing thermoplastics; [1] polyethylene[2] Polyvinyl chloride [3] Acetyl [4] polyamides

3. List the properties and assess the typical applications of the following thermoplastics [1] PTFE [2] PMMA[3] PET [4] PEEK [5] PE

4. Explain in the following : PET,PC, PA, ABS

5. What are the special properties of plastics that make them suitable for engineering a pplications? Describe the concept of 'Co-polymerization'

6. Name suitable alloys , polymers and ceramics for manufacturing the following items. 1.Bush 2.furnace heating element 3.lathe bed 4.coins 5.girders for airship 6.Big end bearing 7.Turbine blade 8. knobs

7. Describe the properties and applications of following structural ceramics a. Alumina and Partially stabilized zirconia(PSZ) b. Silicon carbide and Silicon nitride c. Sialon

8. With the schematic diagram illustrate the processing of reinforced composites

UNIT – V

MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS

1. **Define endurance limit in fatigue test. (May/June 2006)**
   - ❖ Endurance limit is defined as the value of stress below which the material will not fail even when it is loaded for infinite number of cycles.
2. **What properties are determined from tension testing of metallic products? (May/June 2006)**
   - ❖ Limit of proportionality
   - ❖ Yield strength
   - ❖ Maximum tensile strength
   - ❖ Breaking strength
   - ❖ Percentage elongation
   - ❖ Modulus of elasticity
3. **Distinguish between slip and twinning. (May/June 2007)**

S.No	Slip	Twinning
1.	It occurs along individual slip planes.	It occurs over general crystallographic planes.
2.	The atomic movements are over long distances.	The atomic movements are over a fraction of atomic spacing.
3.	Deformation takes place due to the sliding of atomic planes over the others.	Deformation is due to orientation of one part of the crystal with respect to the other.
4.	Slip takes place, when shear stress reaches revolved critical shear stress.	These is no role for resolved critical shear stress.

4. **How will you express the deformation characteristics of a material through tension test? (May/June 2007)**
   - ❖ The deformation characteristics of a material through tension test expressed as the stress – strain curve.
   - ❖ With the help of stress – strain curve, the various tensile properties such as elastic stress, strain, yield strength, ultimate strength, young's modulus etc., are calculated.
5. **How many one distinguish between slip and twinning if the width of the twih band is of the same order as a slip line? (Nov/Dec 2007)**
   - ❖ The twinning differs from slip in that every plane of atoms suffers some movement and the crystallographic orientations of many unit cells are altered.
6. **Why are impact specimens notched? (Nov/Dec 2007)**
   - ❖ The impact specimens are notched because the impact test also indicates the notch sensitivity of a material.
   - ❖ The notch sensitivity refers to the tendency of some ductile materials to behave like a brittle materials in the presence of notches
7. **What are slip bands? (April/May 2008)**
   - ❖ Slip bands are made up of several slip planes. They indicate that the atomic planes within the crystal have sheared with respect to each other
8. **What are different types of loading available for fatigue testing? (April/May 2008)**
   - ❖ Shock or impact load
   - ❖ Static load
   - ❖ Random load
   - ❖ Repeated or reversed load
9. **Define fatigue. (Nov/Dec 2009)**

- The capacity of material to withstand for a repeatedly applied stresses is known as fatigue.

10. List the testing methods of metals. (Nov/Dec 2009)

- Tensile test
- Impact test
- Bend test
- Fatigue test
- Torsion test
- Creep test

11. What is twinning in metals? (April/May 2010)

- Twinning is the process in which the atoms in a part of a crystal subjected to stress, re-arrange themselves so that one part of the crystal becomes a mirror image of the other part.

12. What is the difference between HRB and HRC ? (April/May 2010)

There are many rockwellScales :

- **B – Scale** [1/16 inch diameter steel ball indenter ; 100kg load] Used to measure the hardness (HRB) of non – ferrous metals.
- **C – Scale** [120^{o} diamond core indenter, called a BRALE ; 150kg load] Used to measure hardness (HRC) of steels.

13. What is the chief effect of notch in the fracture process? (April/May 2011)

- Notches in the metal provide stress concentration centres and hence increase the transition temperature. At transition temperature, the brittleness increases suddenly.

14. With a simple sketch show the phenomenon of slip in metallic materials. (April/May 2011)

- The slip occurs by translatory motion along sliding planes and notation of the specimen

15. Define toughness. (Nov/Dec 2011)

- Toughness is the property of a material by virtue of which it can be absorb maximum energy before fracture takes place.

16. Differentiate between Izod and Chalpy impact testing. (May/June 2012)

- Izod test uses a cantilever specimen of size 75 mm × 10 mm × 10 mm. The V – notch angle is 45^{o} and the depth of the notch is 2 mm.
- The chalpy test uses a test specimen of size 55 mm × 10 mm × 10 mm. The V – notch angle is 45^{o} and the depth of the notch is 2 mm. The chalpy specimen is placed in the vice as a simply supported beam.

17. What does impact test signify? (May/June 2013)

- The impact test is performed to study the behavior of material under dynamic load (i.e., suddenly applied load)

18. What do you understand by the plastic deformation?(May/June 2013)

- Plastic deformation is the deformation of a body which remains even after removing the external load from the body.

19. Differentiate between fatigue and creep tests. (Nov/Dec 2013)

- Fatigue tests determine the resistance of material to repeated pulsating or fluctuating loads.
- The purpose of creep test is to determine the creep limit.

20. What S-N diagram? What is the significance of it? (May/June 2014)

- ❖ The S-N diagram is a graph obtained by plotting the number of cycles of stress reversals (N) required to cause fracture against the applied stress level (S).
- ❖ Using the S-N diagram, the fatigue life of a material can be determined.

21. State the Schmid's law.

- ❖ The stress required at a given temperature to initiate slip on a pure and perfect single crystal for a material is constant. This is known as *Schmid'*slaw.

22. What are the factors affecting fatigue strength?

- ❖ Chemical composition
- ❖ Grain size
- ❖ Environmental effects such as corrosion
- ❖ The design of the product

Part B

1. Critically compare the deformation by slip and twinning?

2. Explain the mechanism of plastic deformation of metals by slip and twinning?

3. Write an engineering brief about the creep test?

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?

5. Draw a typical creep curve and explain the various stages of creep

6. Describe with neat sketch fatigue test.

7. With the help of neat sketches explain the difference between brittle and ductile fracture.

8. Describe Brinell hardness test to determine the hardness of a metal.

9. Explain the procedure for performing the Rockwell test.

10. Explain the testing procedure for Vickers hardness test and mention the advantages and limitations.

11. Describe how the torsion test is conducted and what are the properties from this test?