DEPARTMENT OF MECHANICAL ENGINEERING

ME 6403 - ENGINEERING MATERIALS AND METALLURGY

Two Marks with Answers and 16 Marks questions

1. **What are the effects of crystal structure and atomic radii on formation of solid solution between two metallic elements?**

   i) **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.

   ii) Atomic Radii:

   The solute and solvent elements atoms must be of similar size, with less than a 15% difference in atomic radius.

2. **Define Peritectic and Eutectoid reactions.**

   In Peritectic reaction, upon cooling, a solid and a liquid phase transform isothermally and reversibly to a solid phase having a different composition.

   Liquid + Solid 1 $\longrightarrow$ Solid 2

   Eutectoid reaction is an isothermal reversible reaction in which one solid phase transforms into two intimately mixed new solid phases, upon cooling.

   Solid 1 $\longrightarrow$ Solid 2 + Solid 3

3. **State the conditions under which two metallic elements will exhibit unlimited solid solubility.**

   To exhibit unlimited solid solubility, the solute and solvent elements should obey the following general rules of Hume Rothery.
   i) Size factor, ii) Crystal Structure iii) Valence iv) Electro negativity.

4. **Define the terms "Ferrite" and "Austenite" in iron-carbon alloy system.**

   Ferrite is a 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 iron.

5. **Distinguish between hypo-eutectoid steels and hypereutectoid steels.**

   Hypoeutectoid steels:

   Steels having less than 0.8%C are known as hypoeutectoid steels.

   Hypereutectoid steels:

   Steels having more than 0.8%C are known as hypereutectoid steels.

6. **Define peritectoid reaction.**

   Peritectoid reaction is an isothermal reversible reaction in which two solid phases transform into a third solid phase, upon cooling.

   The Peritectoid reaction can be written as

   Solid 1 + Solid 2 $\longrightarrow$ Solid 3

7. What is substitutional solid solution? Give two examples.

When the solute atoms substitute for parent solvent atoms in a crystal lattice, they are called substitutional atoms, and the mixture of the two elements is called a substitutional solid solution.

Example: Cu-Ni system, Cu-Zn system and Au-Cu system.

8. Give an example of eutectoid reaction.

The eutectoid reaction is observed in Fe-C system as shown below.

γ iron (Austenite) $\longrightarrow$ $\acute{\alpha}$ iron (Ferrite) + Fe_3C (Cementite)

9. 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 because austenite is an interstitial solid structure of carbon in iron.

10. List advantages of alloy steels as compared to plain carbon steels.

Better harden ability

Less distortion and cracking.

Improved strength, toughness and resistance to abrasion and wear.

Higher elastic ratio and endurance strength

11. What do you mean by substitutional solid solution? Briefly explain the rules governing formation of substitutional solid solution.

When the solute atoms substitute for parent solvent atoms in a crystal lattice, they are called substitutional atoms and the mixture of the two elements is called a substitutional solid solution.

Hume Rothery's rules govern the formation of substitutional solid solution.

i) Size factor ii) Crystal structure iii) Valence iv) Electro negativity

12. Name and explain any one type of binary solid to solid state transformation reaction with ideal phase diagram?

The eutectoid reaction can be written as

Solid 1 $\longrightarrow$ Solid 2 + Solid 3

The phase reaction of Fe-C eutectoid system is as shown in the fig.

13. Define solid solution.

A solid solution may be defined as a solid that consists of two or more elements atomically dispersed in a single-phase structure.

14. How are steels classified?

Steels can be classified as follows:

1. **Plain Carbon Steels**
   - i) Low carbon steels
   - ii) Medium carbon steels
   - iii) High carbon steels
2. **Alloy Steels**
   - i) Low alloy steels and
   - ii) High alloy steels

15. What are interstitial solid solutions and interstitial compounds?

In interstitial solid solution, the solute atoms fit into the space between the solvent or parent atoms.

The compounds formed by two or more metals in an apparently stoichiometric proportion is called intermetallic compounds.

16. Differentiate between eutectic and eutectoid phase reactions. The **eutectic reaction** can be written as

Liquid $\longrightarrow$ **α solid solution + β solid solution**

The **eutectoid reaction** can be written as

Solid $\rightarrow$ Solid 2 + Solid 3

17. Distinguish between steel and cast iron. Also classify steel with respect to carbon percentage.

The alloys of iron-carbon system containing 0.06% to 2% carbon are known as steel. Those alloys having carbon from 2 % to 6.7% are called cast irons.

Steels that contain 0.8% C are called eutectoid steels. Steels having less than 0.8%C are known as hypo eutectoid steels. Steels having more than 0.8%C are known as hypereutectoid steels.

18. Define substitutional and interstitial solid solution.

In a substitutional solid solution, the solute atoms substitute for parent solvent atoms in a crystal lattice.

In a interstitial solid solution, the solute atoms fit into the space between the solvent or parent atoms.

19. What is eutectoid reaction? Eutectoid reaction can be written as

Liquid $\longrightarrow$ **γ iron (Austenite) + Fe_3C (Cementite)**

20. Name the types of solid solutions. Name and define them

1. **Substitutional solid solution:** When the solute atoms substitute for parent solvent atoms in a crystal lattice, the mixture of the two elements is called a substitutional solid solution.
2. **Interstitial solid solution:** Interstitial solid solution, the solute atoms fit into the space between the solvent or parent atoms.

21. In a iron-carbon phase diagram, at what temperature i) FCC austenite forms and ii) δ Ferrite forms.

i) At 1148°C and ii) At 1465°C

22. What is ferrite?

Ferrite is an interstitial solid solution of carbon in **α_{iron} (BCC)**

23. Define ferrite and cementite in Fe-C alloys.

Ferrite is a primary solid solution based on α iron having BCC structure. Maximum solubility of carbon in iron is 0.025% carbon at 723°C, while its solubility at room temperature is only about 0.008%.

Cementite is the name given to the carbide of iron (Fe_3C). It is the hard, brittle, intermetallic compound of iron with 6.69% of carbon.

Part-B

1. Show the different steel and cast iron region in the iron carbon diagram with its microstructure and write down its composition, mechanical properties and application.
2. Draw a neat sketch and explain TTT diagram.
3. Draw Iron carbon diagram and label all fields?

4. Draw a typical equilibrium diagram for an isomorphous system and explain the equilibrium cooling of any one alloy from the above diagram.
5. Draw a typical equilibrium diagram for a eutectic type of system with limited solid solubility and explain its important features.
6. Explain the Peritectic temperature using a binary equilibrium peritectic phase diagram
7. What is the effect of small quantities of

   (a) Sulphur

   (b) manganese

   (c) phosphorus

   (d) Silicon upon the properties of steel?
8. Explain the method of plotting an equilibrium diagram and derive the lever rule as applied to equilibrium diagram.
9. Discuss the effect of Silicon, Manganese elements in cast iron.
10. Describe the composition, microstructure, properties and applications of grey cast iron.

UNIT - II HEAT TREATMENT

1. **A Low carbon steel in the normalized condition is stronger than the same steel in the annealed condition. Why?**

   Unlike full annealing, the rate of cooling in normalizing is more rapid. Also normalizing process provides a homogeneous structure consisting of ferrite and pearlite for low carbon steels. That's why normalizing produces harder and stronger steels than full annealing.

2. **Case carburizing heat treatment is not generally carried out for medium carbon steels. Why?**

   We know that carburizing process is a diffusion treatment process. For diffusion take place, the host metal must have a low concentration of the diffusing species and there must be a significant concentration of the diffusing species at the surface in the host metal. Since the medium carbon steels lack the above said criteria, they are not generally carburized.

3. **What is "Critical Cooling Rate" in hardening of steels?**

   The slowest rate of cooling of austenite that will result in 100% martensite transformation is known as critical cooling rate.

4. **What is the microstructure of an austempered steel? What is the advantage of austempering heat treatment?**

   The resulting microstructure of the austempering process is bainite. The advantage of austempering are:

   i) Improved ductility
   ii) Increased impact strength and toughness
   iii) Decreased distortion of the quenched material
   iv) Less danger of quenching cracks

5. **What is the principle of surface hardening in induction hardening process?**

   The induction hardening is a process of selective hardening using resistance to induced eddy current as the source of heat.

6. **What is the need for providing a tempering treatment after quench hardening of steels?**

   The quench hardening develops maximum hardness, excellent wear resistance and high strength in the steel. But, it lacks good ductility and toughness; also the internal residual stresses are developed. The tempering is used to relieve the residual stresses and improve ductility and toughness of the hardened steel. That's why quench hardening is always followed by tempering treatment.

7. **Can mild steel be induction hardened? Substantiate.**

   No, mild steel cannot be induction hardened as it contains less than 0.25%C. During induction hardening, mild steel may conduct current instead of forming a magnetic field.

8. **What are the principal advantages of austempering over conventional quench and temper method.**

   v) Improved ductility
   vi) Increased impact strength and toughness
   vii) Decreased distortion of the quenched metal
   viii) Less danger of quenching cracks

9. Mention few applications of induction hardening.

The induction hardening is employed for hardening the surfaces of gears, tool drivers, wrist pins, crankshaft bearing journals, cylinder liners, rail ends, machine tool ways and pump shafts.

10. Name and explain any one subcritical case hardening treatment.

Nitriding is a subcritical case hardening treatment.

Nitriding is a process of introducing nitrogen atoms, to obtain hard surface of steel components.

11. With heat treatment cycle, explain the conventional normalizing treatment for hyper eutectoid steel?

In normalizing, the steel is heated to 50˚C to 60˚C above its upper critical temperature for hyper eutectoid steels. It is held at this temperature for a short time and then allowed to cool in still air.

The normalizing process provides a homogenous structure consisting of pearlite and cementite for hyper eutectoid steels.

12. When will you prefer Carbonitriding?

ix) Carbonitriding is an ideal process for hardening small components where great resistance to wear is necessary.

x) The steels that are commonly carbonitrided are the low-carbon and low-carbon alloy steels.

13. Define hardness.

Hardness may be defined as the ability of a material to resist scratching, abrasion, cutting or penetration.

14. **Define critical cooling rate. (Nov / Dec-12)**

The slowest rate of cooling of austenite that will result in 100% martensite transformation is known as the critical cooling rate.

15. What is the final microstructure in austempering of steels?

The resulting microstructure of the austempering process is bainite.

Bainite is a decomposition product of austenite, consisting of ferrite and carbide.

16. Enumerate any two differences between annealing and normalizing.

S.No	Annealing	Normalizing
1.	Annealing is costly	Normalizing is more economical than annealing (Since no furnace is required to control the cooling rate)
2.	Annealing is more time consuming.	Normalizing is less time consuming.
3.	Annealing temperature is lower than normalizing.	Normalizing temperature is higher than annealing.
4.	It provides coarse grain structure	It provides a fine grain structure.

17. Explain the term 'inducing hardening'.

The induction hardening is a process of selective hardening using resistance to induced eddy currents as the source of heat.

18. Define tempering.

Tempering is the process of heating martensite steel at a temperature below the eutectoid transformation temperature for a specified time period and is cooled slowly to room temperature.

19. Differentiate carburizing and nitriding.

In the carburizing process the diffusing hardening element is carbon. In nitriding process, the diffusion involves nitrogen.

20. What is purpose of spheroidizing heat treatment?

i) To soften steels
ii) To increase ductility and toughness
iii) To improve machinability and formability
iv) To reduce hardness, strength and wear resistance.

21. Define Carburizing.

Carburizing is the process in which carbon atoms are introduced into the surface of low carbon steels to produce a hard case of surface, while the interior or core remains soft.

22. How does internal residual stress develop in metal pieces?

Internal residual stresses are developed in the metal due to cold working, welding, casting, Forging etc…,

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

i) The composition of the steel
ii) The austenitic grain size
iii) The structure of the steel before quenching.

Part-B

1. Describe the method of plotting isothermal transformation or TTT diagram?
2. Draw an IT diagram or TTT diagram for an eutectoid steel .Indicate the various decomposition products on it and explain?
3. Draw a schematic CCT diagram for a carbon steel containing 0.8% C .Using this diagram explain how different cooling curves lead to the (a)Annealing heat treatment

   (b) Normalizing heat treatment

   (c) Hardening heat treatment
4. Explain how Jominy end quench test is used for determining the harden ability of steels.
5. Describe the heat treatment cycle following carburizing.

6. Describe the process of carbonitriding. Differentiate between carburizing and carbonitriding.
7. Explain flame hardening.
8. Explain Induction hardening.
9. Give a detailed account on

   (a) Annealing (b) Normalizing (c) Austempering

   (d) Case hardening.

10. Explain how surface hardening is achieved using flame hardening.

UNIT-III FERROUS AND NON-FERROUS METAL

1. **Compare the martensite that is formed in maraging steels with the martensite that is formed in carbon steels.**

The composition of maraging steel develops martensite upon cooling from the austenitizing temperature. The martensite formed in these steels, unlike the martensite of other carbon steels, is ductile and tough. The ductility and toughness of this martensite result from its very low carbon content.

2. **What is the main strengthening mechanism in high strength aluminum alloys?**

Precipitation strengthening treatment, also known as age hardening, is the main strengthening mechanism in high strength aluminium alloys.

3. **What are the effect of chromium and molybdenum in low alloy steels? The effect of chromium in low alloy steels are to:**

i) Increase corrosion and oxidation resistance
ii) Increase hardenability
iii) Increase high-temperature strength and
iv) Resist abrasion and wear

The effect of molybdenum in low alloy steels are to:

i) Improve high temperature creep resistance
ii) Increase hardenability and
iii) Stabilize carbides

4. **What is the purpose of magnesium treatment in producing S.G. iron?**

The spheroidal cast iron is produced by adding magnesium to molten cast iron. The magnesium converts the graphite of cast iron from flake form into spheroidal or nodular form. The presence of spheroidal graphite improves the ductility strength, fracture toughness and other mechanical properties.

5. **What is the composition of 18/4/1 type high speed steel?**

The 18/4/1 high speed steel contains 18% tungsten, 4% chromium and 1% Vanadium.

6. **List different types of tool steels.**

i) cold work tool steels ii) Shock resisting tool steels iii) Hot work tool steels iv) High speed tool steels v) Plastic mold tool steels vi) Special purpose tool steels

7. **Mention any two aluminium base alloys and their applications.**

1. Duralumin: i) Used for aircraft and automobile industries.
ii) For making electric cables, in surgical and orthopedic implements etc..,
2. Y-alloy: Used for making pistons of engines, cylinder heads, gear boxes, propeller blades etc..,

8. **How does silicon addition influence the properties of steel?**

The effects of silicon addition in steels are:

Silicon acts as a general purpose deoxidizer.
Silicon improves electrical and magnetic properties.
Silicon improves oxidation resistance.
Silicon strengths low alloy steels.

9. What is carbonitriding?

Carbonitriding is a surface hardening process that involves the diffusion of both nitrogen and carbon into the steel surface.

10. Write short notes on the types of stainless steels.

i) Austenite stainless steels: They have the austenite structure retained at room temperature.

ii) Ferrite stainless steels: They have ferritic in structure at all temperatures up to their melting points.

iii) Martensitic stainless steels.

11. With composition, property and application explain a) Tin Bronze b) Naval Brass

Alloy Name	Composition (wt %)	Properties	Typical Applications
1.Tin Bronze (Bell Bronze)	78 CU, 22 Sn	Hard and brittle	For making bells, coins, medals etc…,
2.Naval Brass	59 Cu 40 Zn, 1 Sn	Can be forged and extruded Corrosion resistant	For marine and engineering structural uses.

12. Name the alloying elements in high speed steel.

Tungsten, Chromium and Vanadium

13. State the applications of tool steel.

i) The tool steels are used in the following applications :
General tool and die applications in which resistance to distortion or cracking is needed.

ii) Die work, including blanking, drawing thread rolling as well as gauges, rolls for forming sheet metal etc..,

iii) Pneumatic tools, hand chisels, cold cutters, punches, heavy duty shear blades.

iv) General purpose steel for tools operating at high cutting speeds, such as drills, reamers, broaches, milling cutters, hobs, saws, etc…,

v) Tools for hot forging machines, hot trimming tools, hot blanking and extrusion dies etc..,

14. What are the effects of adding Si in steels?

i) Acts as a general purpose deoxidizer.

ii) Improves electrical and magnetic properties.

iii) Improves oxidation resistance.

iv) Strengthens low alloy steels.

v) Increase hardenability of steels carrying non-graphitizing elements.

15. Differentiate brass from bronze.

Brass is an alloy of copper and Zinc. (Cu and Zn)
Bronze is an alloy of Copper and Tin (Cu and Sn)

16. List the parameters that can be determined from the tensile test.

i) Limit of proportionality.
ii) Yield point or yield strength
iii) Maximum tensile strength
iv) Breaking strength
v) Percentage elongation
vi) Percentage reduction in area and
vii) Modulus of elasticity

17. Mention some of the disadvantages of Brinell hardness test.

a) It cannot be used in very hard or very soft materials.
b) The test may not be valid for thin specimen
c) The test should be conducted on a location far enough removed from the edge of the material so that no edge bulging results.
d) The test is not valid for case-hardened surfaces.

18. What is critical state?

It represents the highest pressure and temperature at which the liquid and vapour phase coexists in equilibrium. At the critical point the liquid and vapour phases are indistinguishable. Liquid directly converted into vapour.

19. Classify the different hardness testing methods.

i) Brinell hardness test
ii) Vickers hardness test
iii) Rockwell hardness test

20. Name the typical properties and applications of high-strength low-alloy steels.

i. The primary purpose of HSLA steels is weight reduction through increased strength.
ii. The HSLA steels are widely used as structural or constructional alloy steels.

21. Name some of the common uses of brass alloy.

Typical applications include imitation jewellery, decorative work, making coins, medals, Fuse caps, for press-work, cold forming, radiator cores, for extruding rods and tubes etc….,

22. How do you enhance the mechanical strength of aluminium?

By alloying aluminium with one or more alloying elements such Cu, Mg, Mn, Si and Ni.

23. Specify the % of carbon content in a) grey CI and b) White CI

i) Grey CI - Carbon 2.5% to 4%
ii) White CI - Carbon 1.8% to 3%

24. What is critical point? What are the properties of water at critical points?

It represents the highest pressure and temperature at which the liquid and vapour phases coexist in equilibrium. At the critical point the liquid and vapour phases are indistinguishable. Liquid directly converted into vapour.

25. Define 'Creep' of metals.

The continuous deformation of a metal under a steady load is known as creep.

Part-B

1. Write short note on compositions and properties of the following stainless steels,

   (a) Ferritic stainless steel

   (b) Austenitic stainless steel

   (c) Martensitic stainless steel

   (d) Precipitation hardening stainless steel

2. State the types, compositions and properties of high speed steel.
3. Discuss Hadfield and Mar aging steels on the following lines

   (a) Chemical composition

   (b) Heat treatment

   (c) Mechanical properties

   (d) Applications

4. Explain the various methods to achieve high strength in HSLA steels.
5. Explain Bearing alloys.
6. Explain Tool steels.
7. Name different alloys of copper. Give its composition, properties and uses.
8. Explain Mar aging steels.
9. Explain Stainless steels, High speed steels.
10. Explain, bearing metals, Explain brasses

UNIT-IV NON-METALLIC MATERIALS

1. **Name four ethenic polymers (polymers that have the basic monomer structure of ethylene)**
   i) Polypropylene (PP)
   ii) Polyethylene (PE)
   iii) Polyvinyl chloride (PVC) and
   iv) Polystyrene (PS)

2. **What are the important uses of alumina and silicon nitride?**

i) Alumina ceramics are used for any type of load-bearing application. They are used fro rocket nozzles, pump impellers, pump liners, chuck valves, nozzles subject to erosion and for support members in electrical and electronic devices.
ii) Silicon nitrides are widely used as cutting tool materials.

3. **Draw the molecular structure of polyethylene and polypropylene.**

4. **Give one example each for metal-matrix composites and ceramic-matrix composites.**
   Examples for metal-matrix composites: Ag-CdO, Al-Al_2O_3
   Examples for ceramic-matrix composites: Tungsten carbide, Aluminium oxide, Titanium boride

5. **Write the molecular structure of either Phenol-formaldehyde (PF) polymer or urea-formaldehyde (UF) polymer.**

6. **Give two examples of particulate reinforced metal matrix composites.**
   i) Sintered aluminium powder (Al / Al_2O_3)
   ii) Cermet.
7. **Name any four common engineering polymers.**
   i) Ethenic ii) Polyamides iii) Silicones iv) Polyimides

8. **What are the uses of aluminium oxide?**
   i) Used as a refactory material for high temperature applications.
   ii) Used for cutting cast iron and steels.
   iii) Used as an abrasive material in grinding wheels.
9. **What do you mean by copolymers?**
   Copolymers are polymers which are obtained by adding different types of monomers.
10. **How are refractories classified?**
    i) Fire clay refractories. ii) Silica refractories iii) Basic refractories and iv) Special refractories.

11. With property and application, explain the following polymers:

i. PVC b) PMMA

ISO Abbreviation	Polymer Name	Properties	Typical Applications
1.PVC	Poly Vinyl Chloride	Good low-cost, general purpose materials Ordinary rigid, but can be made flexible with plasticizers Susceptible to heat distortion	Pipes, Valves, fittings, floor tiles, wire insulations,toys,safety glass interlayer's
2.PMMA	Poly Methyl Metha-Crylate	Hard, rigid and high impact strength Highly transparent to light Excellent decorative properties	Camera lenses, flashlights, safety glasses, drafting equipments, instrument panels, display signs, transparent aircraft enclosures, windows.

12. Write the general mechanical properties of ceramics.

1. Ceramics are strong, hard and brittle.
2. They are good thermal and electrical insulators.
3. They have high compressive strength but are weal in tension.
4. They have high resistance to abrasion and wear.

13. Define degree of polymerization.

It is the number of repetitive units present in one molecule of a polymer. It is a parameter used to designate the average chain size of a polymer. Mathematically,

Degree of polymerization = Molecular weight of a polymer / Molecular weight of a single monomer.

14. State any two properties of Ceramics.

a) High resistance to abrasion and wear.
b) High strength at high temperature
c) Good Chemical stability
d) Good electrical insulation characteristics.

15. **What are PMMA and PET polymers? What are their uses?**

PMMA (Polymethyl Methacrylate) also commonly known as Perspex or plexiglass, is produced by the addition polymerization of methyl Methacrylate.

Applications: Typical applications of PMMAs include camera lenses, flash lights, safety glasses, drafting aircraft enclosures and windows.

16. What are the uses of alumina?

High alumina ceramics are used for the manufacture of spark-plug insulators, ceramic / metal assemblies in vacuum tubes, substrates for the deposition of electronic microcircuits and metal-cutting tool tips. They are suitable for any type of load-bearing application. They are used for rocket nozzles, pump impellers, pump liners, check valves, nozzles subject to erosion and for support members in electrical and electronic devices.

Some unique applications of alumina are in dental and medical use, including restoration of teeth, bone filler and orthopedic implants.

These materials find application in nuclear equipment.

17. What will be the effects, if the following elements alloyed with steel?

ii. **Phosphorous :**

Phosphorous is usually added with sulphur to improve machinability in low alloy steels. Phosphorous in small amounts, aids strength and corrosion resistance.

iii. **Sulphur :**

When sulphur is added in small amounts with steel, it improves machinability by does not cause hot shortness.

18. Write down the composition and any one applications of the following alloys:

i) Duralumin ii) Brass

i. **Duralumin :**

Composition: 94% Al, 4% Cu, 0.5% Mg, 0.5%Mn

Properties: It is a wrought alloy, possesses maximum strength after age hardening, High strength –to-weight ratio.

ii. <u>Brass :</u>

Brass is an alloy of Copper and Zinc

Properties: They are stronger, they have lower thermal and electrical conductivity, and they can be cast into moulds.

19. What is inoculation?

Inoculation is nothing but grain refinement when a metal casting freezes, impurities in the melt and walls of the mold in which solidification occurs serve as heterogeneous nucleating sites. Sometimes we intentionally introduce nucleating particles into the liquid. Such particles are called grain refinement or inoculation.

20. What is precipitation hardening?

Precipitation hardening, also known as age hardening, is the method of improving the physical properties of some of the non-ferrous alloys by solid state reaction.

28. Name some major applications of ABS and PTFE material.

Typical applications of ABS include toys and modeling kits, mouldings for office and domestic appliances, boxes and cases. Typical applications of PTFE include chemically resistant coatings, non-stick coatings, anticorrosive seals, chemical pipes and valves, bearings etc..,

29. Mention some typical applications of carbon fiber reinforced composite material.

Aerospace and automotive applications, wear and marine applications, sporting good equipment.

30. What is the structure difference between white cast iron and grey cast iron?

White cast iron derives its name from the fact that its fracture surface has a white or silvery appearance.

The microstructure of grey cast iron consists of graphite flakes, which resemble a number of potato crisps glued together at a single location.

31. Name any two precipitation hardenable alloys.

1. Aluminium – Copper alloy
2. Copper - Beryllium alloy

Part-B

1. Explain the properties and application of the PVC,PE, PTFE, ABS
2. Give the detailed account on:
   (a) Urea formaldehydes
   (b) Fibre reinforced plastics
   (c) Cellulose nitrate.
3. Explain PMMA.
4. What is polymerization? Describe addition polymerization and condensation polymerization.
5. How plastic materials are classified? Explain each classification.
6. Write brief notes on following traditional ceramics
   (a) Clay products
   (b) Glasses
   (c) Cements
   (d) Refractory's
7. Describe the properties and applications of following structural ceramics
   (a) Alumina
   (b) Partially stabilized zirconia
   (c) Silicon carbide (d) Silicon nitride (e) Sialon
8. Describe the structures, properties and applications of following commodity thermoplastic polymers
   (a) Polyethylene
   (b) Polyvinylchloride
   (c) Polystyrene
9. Describe the strictures, properties and applications of the following commodity thermoplastic polymers
   (a) Acrylonitrile Butadiene Styrene
   (b) Polytetrafluoroethylene
   (c) Nylons
   (d) Polycarbonates
   (e) Polyethylene terephthalate
10. Describe the structures, properties and applications of the following thermoset polymers
   (a) Phenol formaldehyde
   (b) Urea formaldehyde
   (c) Epoxies
   (d) Unsaturated polyesters

UNIT-V MECHANICAL PROPERTIES AND DEFORMATION MECHANISM

1. **Define endurance limit in fatigue test.**

   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?**

   i) Limit of proportionality ii) Yield strength iii) Maximum tensile strength iv) Breaking strength v) Percentage elongation and vi) Modulus of elasticity.

3. **In general, HCP metals are hard and brittle while FCC metals are soft and ductile. Why?**

   FCC structure has a large number of closed packed planes and close-packed directions. So metals possessing FCC structure are more ductile than HCP structure.

4. **Draw the sketch of a standard specimen used for charpy V-notch impact testing.**

   The adiabatic saturation process is another way of determining the absolute or relative humidity. The process is illustrated in the figure. A steady stream of unsaturated air at ω_1 and T_1 passes through the channel.

5. **Distinguish between slipping and twinning.**

S.No	Slipping	Twinning
1.	In Slipping, the deformation takes place due to the sliding of atomic planes over the others.	In Twinning, the deformation is due to orientation of one part of the crystal with respect to the other.
2.	It occurs along individual slip planes.	It occurs over general crystallographic planes.
3.	The atomic movements are over large distances.	The atomic movements are over a fraction of atomic spacing.
4.	There is no change in the orientation of the atoms after slip has occurred.	Twinned atoms undergo a change in their orientation and become mirror of the untwined atom.
5.	Slip takes place when shear stress reaches resolved critical shear stress.	There is no role for resolved critical shear stress.

6. **How will you express the deformation characteristics of a material through tension test?**

   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.

7. How may one distinguish between slip and twinning if the width of the twin band is of the same order as a slip line?

The twinning differs from slip in that every plane of atoms suffers some movement and the crystallographic orientations of many unit cells are altered.

8. Why are impact specimens notched?

The impact specimens are notched because the impact test also indicated the notch sensitivity of a material.

The notch sensitivity refers to the tendency of some normal ductile materials to behave like a brittle material in the presence of notches.

9. What are slip bands?

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.

10. What are the different types of loadings available for fatigue testing?

i) Shock or Impact load.
ii) Static load
iii) Random load
iv) Repeated or reversed load.

11. What is creep? Draw a typical creep curve and show different creep stages on it.

The creep is defined as the property of a material by virtue of which it deforms continuously under a steady load.

12. Define fatigue.

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

13. List the testing methods of metals.

Tensile test, impact test, bend test, fatigue test, torsion test, creep test.

14. What is twinning in metals?

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

15. What is the difference between HRB and HRC?

There are many Rockwell scales. But the most commonly used are:

i) B-Scale (1/16 inch diameter steel ball indenter, 100 kg load) used to measure the hardness (**HRB**) of non-ferrous metals.

ii) C-Scale (120° diamond cone indenter, called a BRALE, 150kg load), used to measure the hardness (**HRC**) of steels.

16. Name any two polymers and state their applications.

i) **Polyethylene :** Used as packing films, wire insulation, squeeze bottles, tubing, piping's, housings, toys, ice trays, house wares.

ii) **Polystyrene :** Used for low-cost transparent mouldings such as CD cases, ball-point pens, food boxes, lighting panels, toys, battery cases, etc..,

17. Mention any four attractive properties of engineering ceramics.

a. High resistance to abrasion and wear.
b. High strength at high temperature.
c. Good chemical stability
d. Good electrical insulation characteristics.

18. Distinguish polymer and ceramic with respect to mechanical and physical properties.

Property	Polymers	Ceramics
Mechanical Properties		
Tensile strength,	30 max	100 max
Field strength,	25 max	Does not yield
Elongation and compressive strength	Can be 100%	Zero
Physical Properties		
Density	0.03 to 0.1	0.1 to 0.6
Melting Point	<500°C	>5000°C
Thermal Co-efficient of expansion	Very high	Low

19. What is the chief effect of notch in the fracture process?

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

20. What is the structure of polyethylene? Suggest any two uses.

Uses:

Typical applications of polyethylene include packing films, wire insulation, squeeze bottles, tubing, pipings, housings, toys, ice trays, housewares.

Part-B

1. Describe with neat sketch fatigue test.
2. Describe with neat sketch creep test.
3. Explain the mechanism of plastic deformation by slip and twinning with neat sketch.
4. Describe how the torsion test is conducted and what are the properties deter from this test?
5. Explain the testing procedure for Vickers hardness test and mention the advantages and limitations.
6. Describe the procedure of Charpy impact testing and the properties obtained from it.
7. Explain the method of testing the materials for fatigue and how is the fatigue data presented.
8. Draw a typical creep curve and explain the various stages of creep.
9. What is meant by ductile fracture? Explain the mechanism of it.
10. Compare and contrast the Brinell, Vickers and Rockwell hardness tests.