ME8491 - ENGINEERING METALLURGY
UNIT- I / ALLOYS AND PHASE DIAGRAMS

PART-A:

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 1140^0C.

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 another.

- To 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 $\longrightarrow$ 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:

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-Fe_3C 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?

UNIT- II / HEAT TREATMENT

PART-A:

1. Define Normalizing and Hardening process.
   - Normalizing is a heat treatment obtained by austenizing and air cooling to produce a fine pearlite structure.
   - Hardening is heat treatment process it which increases the hardness by quenching.

2. Explain carburizing and nitriding.
   - Carburizing is a process in which carbon atoms are introduced on to the surface of low carbon steels to produce a hard case of surface while the interior or core remains soft.
   - Nitriding is defined as the process of introducing both nitrogen and carbon to obtain hard surface of the steel component.
3. What is the use of the isothermal transformation diagram?

   It's a plot of temperature versus the logarithm of time for a steel alloy and composition it is used to determine the transformation begins and end for an isothermal constant temperature (heat treatment)of a previously austenitized alloy.
4. Name the various method of heat treatment of steel.

   a. annealing b. nitrining c. carburizing
5. Explain the term Stress relief annealing and Spheroidizing.
   - Stress relief annealing is the heat treat to remove residual stress caused by machining, grinding, non cooling of metal, phase transformation with different densities.
   - Spheroidizing means Medium & High carbon steels are changed their grain structure from coarse pearlite to spherodite structure to get softness and ductility for easy machining.
6. Differentiate between Tempering and Maraging.
   - Tempering **is the process of heating martensite steel to250' c to 650 c' to get the** property of ductility & toughness.
   - Maraging steels are low carbon high alloy steels, which is very high strength material that can be hardened to obtain tensile strengths up to 1900MPA. NI-18%, CO-7% and small amount of other elements such as titanium the carbon content is low less than 0.05%
7. Define the term heat treatment.

   Heat treatment may be defined as an operation or combination of operations involving heating and cooling of a metal in solid state to obtain desirable properties
8. What are the purposes of processing heat treatments?

   To relieve internal stresses, to improve machinability, to refin grain size, to soften the metal.
9. Explain the purpose of annealing.

   To remove stresses, To induce softness, To refine grain structure, To remove gases.
10. Define quenching stages for quenching.

    Quenching refers accelerated cooling
    - Vapour –jacket stage
    - Vapour-transport cooling stage
    - Liquid cooling stage
11. What is a CCT diagram?

    The CCT diagram is a plot of temperature versus the logarithm of time for steel alloy of definite composition. It is used to indicate when transformations occur as the initially

austenitised material is continuously cooled at a specified rate. In addition, it is also used to predict the final microstructure and mechanical characteristics.

12. In what ways flame hardening differs from induction hardening.

    The mechanism and purpose of induction hardening are the same as for flame hardening. The main difference is that induction hardening the source of heat input is an induced electric current instead of using flame.

13. List some of the surface hardening techniques employed for altering surface chemistry.

    - Diffusion methods

    (a) Carburizing (b) Nitriding (c) Cyaniding (d) Carbonitriding

    - Thermal methods

    (a) Flame hardening (b) Induction hardening

14. What do you meant by the term case hardening?

    In many applications, it is desirable that the surface of the components should have high hardness, while the inside or core should be soft. The treatments given to steels to achieve this are called surface heat treatments or surface hardening

15. Case carburizing treatment is not generally carried out for medium carbon steels. Why?

    The 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.

16. In what ways cyaniding differs from carburizing.

    The salt both compositions for cyaniding give a case high in nitrogen, whereas carburizing gives a case rich in carbon

17. 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

18. Mention few applications of induction hardening.

    The induction hardening is employed for hardening he surfaces of gears, tools, wrist pins, crank shaft bearings, machine tool ways and pump shafts.

19. List the advantages of austempering.

    Improved ductility, increased impact strength and toughness, decreased distortion of the quenched metal, less danger of quenching cracks.

20. What is Flame hardening?

    Flame hardening is case hardening consisting of heating the selected areas of steel into the austenite range with an oxyacetylene or oxyhydrogen flame and immediately quenching it to form martensite.

21. Mention the different methods of heat treatment.

    Annealing, Tempering, Hardening, Austempering, Martempering, Normalizing and spheriodising are some of the heat treatment of metals

22. Describe the factors affecting mechanical properties of metals.

    1. Grain Size - Smaller grain size posses higher strength.
    2. Heat treatment

23. What is T-T-T diagram?

    T-T-T diagram is also called isothermal transformation diagram [Temperature-Time – Transformation]. It is a plot of temperature verses the logarithm of time for a steel alloy of definite composition. It is used to determine when transformations begin and end for an isothermal [constant thermal] heat treatment of a previously austenitized alloy.

24. Why has gas carburizing largely replaced other methods of carburizing in mass production operations?

Because of the following reasons the gas carburizing replaces the other methods.

- Less time is required than pack carburizing.
- Less floor space is required.
- Cleaner surroundings,
- Closer quality control.

25. Explain sub-zero treatment of steel.

Whenever the steel is hardened some amount of austenite is always retained by it. This results in the reduction of hardness, thermal conductivity and wears resistance. The sub-zero treatment of harden steel reduces the retained austenite. In this process the hardened steel part is cooled to sub-zero temperatures. [between -30 ^{0}C to -120^{0}C] 26. **What is "Patenting"?**

A special application of isothermal hardening is called patenting and is used for steel wire.. Steel wire with 0.40 – 1.10% carbon is quenched from the temperature in a bath of molten lead to about 4000 C to 5000 C. A structure with possess good ductility in addition to a hardness.

27. Define tempering.

Tempering is the process re-heating the hardened steel to some temperature below its critical temperature in order to impart toughness and to reduce brittleness. This reduces the internal stresses developed during hardening.

28. What is the basic difference between cyaniding and carbo-nitriding?

CYANIDING	CARBO-NITRIDING
Ferrous materials heated above the lower transformation range in a molten salt NaCN, Na_2CO_3 & NaCl	Ferrous metal is heated above the lower transformation range in a gaseous atmosphere of suitable composition.

29. Explain the two types of surface hardening methods.

The two types of surface hardening methods are.

1. Diffusion methods:

These methods involve heating the entire sample to a particular temperature, in a suitable atmosphere, so that absorption of foreign atoms and consequent diffusion takes place. This results in hardening of surface of few hundred microns depth.

2. Non-diffusion methods:

These methods involve hardening the surface by heating and then subsequent cooling.

30. What is laser surface hardening?

Use of high power laser to harden the surface of a material is known as laser surface hardening. The metal (Steel) is heated to higher temperatures and quenched in water.

31. Explain annealing. Classify it.

Steels of 0.3 to 0.6% C content is heated 300 C to 40oC above upper critical Temperature line and cooled in a furnace atmosphere. This heat treatment relives the internal stresses and improves the ductility of steels.

1. Full Annealing
2. Process Annealing
3. Spheroidisation Annealing
4. Stress Relief Annealing

32. What is re-crystallization Temperature?

The minimum temperature at which new crystals are formed with in the materials while heating.

33. Define Spherodizing Annealing. What is the main Advantage of Spherodizing

    The steels are heated to a temperature just above the critical and cool very slowly (About 60C per hour) through the critical range. This causes all carbides in the steels at agglomerate in the form of globus or spheroids. This spheroids improves the machinablity and surface finish of the machined parts.

34. Explain CCR.

    The minimum cooling rate at which all of the austenite is super cooled , and is transformed into martensite is called CRITICAL COOLING RATE. The magnitude of critical cooling rate depends on the stability of the austenite. The higher the Stability of the austenite, the less the critical cooling rate. Eutectoid steels have the lowest critical cooling rate.

35. What is Flame Hardening? Where it is used?

    It is a process of surface hardening by which steel or cast iron is heated to high temperature by a gas flame and then almost immediately quenched.This process of hardening is used for hardening of wheel teeth and lathe bed.

36. Define Hardenablity

    Hardenability refers the ability to develop its maximum hardness when subjected to the normal hardening heating and cooling cycle. Maximum hardness obtainable with steel of given composition

37. Write the factors affecting hardenablity of materials.

    Carbon content, Structure of the material- Grain size, Homogeneity of composition, Medium and process of quenching, Heating rate time,

38. What is Austempering?

    Heat the steel to the austenite temperature state then quenching it in a bath held above the temperature at which martensite begins to form. The steel then remains at that temperature until the austenite is completely transformed into banite, after which it is allowed to cool.

39. Enumerate Martempering?

    Martempering is a hardening treatment that consists of heating a steel to its austenite steel and then quenching it to a temperature just above which martensite starts to form. The cooling rate must be faster than the critical cooling rate. The steel is then held at that temperature for sufficiently long time for the entire piece of steel to come to the same temperature, without any transformation to banite occurring. It is then cooled in air to change the austenite to martensite.

PART-B:

1. Explain the difference between TTT diagram and iron –carbon equilibrium diagram.
2. Describe why are TTT diagrams usually not applicable to industrial engineering practices?
3. What are the differences between surface hardening by diffusion methods and thermal methods?
4. Define the following surface hardening process:
   (a) Carburishing (b) Nitriding (c) Cyaniding (d) Carbonitriding.
   (e) Difference between pack carburizing and gas carburizing?
5. What do you understand by hardening of steel? Discuss the reason why martensite is very hard. Also discuss the various characteristics of martensite transformation.
6. Draw a neat sketch of the TTT diagram for eutectoid steel and label the regions. Mark the difference products formed on this diagram.

7. What is a CCT diagram? Describe various cooling curves on CCT diagrams. How such curves are drawn? Write short notes on critical cooling rate.
8. What is meant by carburizing of steels? Briefly explain the various types of carburizing.
9. Explain the process of nitriding. List and discuss the advantages of nitriding over carburizing.
10. Give a detailed account on annealing, normalizing, austempering and case hardening.
11. Distinguish between annealing and normalizing.
12. Explain how surface hardening is achieved using flame hardening.
13. Define the types of annealing Process and explain it?
14. Demonstrate Isothermal Transformation diagram (TTT) or (c-curve) or (s-curve)
15. Brief about tempering process and explain CCT diagram.
16. Enumerate Martempering and Austempering.
17. Explain the following case hardening process: i) Carburising ii) Carbo-nitriding iii) Induction hardening iv) Nitriding v) Flame hardening

UNIT- III / FERROUS AND NON-FERROUS METALS

PART-A:

1. What are alloy steels? How are alloy steels classified

   Alloy steels mean may steels other than steels. Alloy steels can be divided into two main groups:
   1. Low alloy steels: These contain upto 3 to 4% of alloying elements
   2. High alloy steels: These contain more than 5% of alloying elements
2. Explain stainless steels.

   Stainless steel is alloy of iron, Cr, and other elements that resist corrosion from many environments.
3. What is meant by maraging steel?

   Maraging steels contain 18% nickel, 7% cobalt and small amounts of other elements such as titanium. The carbon content is generally less than 0.05%. To produce a uniform austenite structure, it requires solution treatment at 800- 850^{0}C followed by a rapid quenching. After solution treatment they are soft enough to be worked and machined with comparative ease.
4. Define tool steel.

   Tool steel are metal used to make tools and ties for cutting forming or otherwise shaping a material into a components or part for a specific applications. Tool steel are metals designed to provide wear resistance and toughness combined with high strength.
5. Name some of the Tool steel.
   1. High Speed steel - Molbdenum grade, Tungsten grade
   2. Cold worked steels (High carbon high chromium grade)
   3. Special purpose steel - Low alloy grade, Carbon tungsten grade
6. Name any two types of aluminium alloys.

   Heat treatable aluminium alloy and non heat treatable aluminium alloy.
7. What are bearing materials?

   The materials which are used for making bearing are known as bearing materials.
   Ex: White metal, copper base alloy, AL-base alloy, plastic materials and ceramics
8. Define the term copper.

   Copper is a highly ductile metal with high electrical conductivity and the pure metal is used in many electrical and electronic application.
9. Enumerate the important types of copper alloys.

Brasses [CU-ZN alloys], Bronzes [CU-SN alloy, Gun metal [CU-SN- ZN alloy], cupronickels [cu-ni alloy]

10. Describe precipitation hardening.

    It is the most important method of strengthening hardening the most of non ferrous alloys by solid state reaction.

11. What is cast iron?

    Cast-iron can be defined as the ferrous alloy with greater than2% carbon they also contain small amount of silicon manganese and phosphorus.

12. List the properties of steel.

    Ductility, Hardness, Machinability, Shock resistance and Toughness

13. Define metals. Classify engineering metals.

    Metals are elemental substances. Metals are composed of elements which readily give up electrons to provide a metallic bond and electrical conductivity

    Types of metals: 1. Ferrous metals. 2. Non-Ferrous metals.

14. State three reasons why ferrous alloys are used extensively

    Iron based components are relatively abundant and are widely distributed throughout the world. Ferrous materials can be produced very economically. Ferrous materials are versatile. Therefore wide range of mechanical and physical properties of ferrous materials can be achieved

15. State three characteristics of ferrous alloys that limit their utilization

    Heavy in weight, lower electrical and thermal conductivity, lower resistance to corrosion

16. Why is alloying done?

    To increase strength, to improve hardness, to improve toughness, to improve machinability.

17. List four important alloying elements added in alloy steels.

    The most commonly used alloying elements are chromium, nickel, molybdenum, vanadium, tungsten, cobalt, boron, copper and others

18. What are the required good properties of a tool steel?

    Good toughness, Good wear resistance, Very good machinability, Resistance to softening on heating

19. Define 18-4-1 high speed steel.

    Widely used high speed tool steel is 18-4-1 high speed steel. This steel contains 18% tungsten, 4% chromium, 1% vanadium. It is considered to be one of the best of all purpose tool steels.

20. Explain HSLA steels.

    HSLA steels are nothing but high strength low alloy steels. HSLA steels also known as micro alloyed steels, are low carbon steels containing small amounts of alloying elements.

21. What are the effects of carbon on the properties of cast iron?

    If a cast iron contains more of the brittle cementite, then it is mechanical properties will be a poor

22. Write the chemical composition of grey cast iron.

    Carbon-2.5 to 4%, Silicon-1 to 3%, Manganese – 0.4 to 1%, Phosphorus-0.15 to 1%, Sulphur -0.02 to 0.15%, remaining is iron

23. List some bronze alloys.

    Bell bronze, phosphor bronze, aluminum bronze, silicon bronze, coinage bronze, and leaded bronze

24. What are cupronickels? What is the use of monel metal?

Cupronickels are alloys of copper and nickel. Uses of Monel metal: For making propellers, pump fittings, condenser tubes, steam turbine blades, sea water exposed parts, tanks, and chemical and food handling plants.

25. Define the process **"**precipitation hardening**".**

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

26. 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 aluminum alloys.

27. Explain the effect of chromium and molybdenum in low alloy steels.

- The effect of chromium in low alloy steels are to: Increase corrosion and oxidation resistance, Increase hardenability and high temperature strength, Resist abrasion and wear.
- The effect of molybdenum in low alloy steels are to: Improve high temperature creep resistance, Increase hardenability, Stabilize carbides.

28. Mention any two aluminium base alloys and their applications.

Duralumin: Aircraft and Automobile industries - For making electric cables, in surgical and orthopedic implements etc.

Y-alloy: Pistons of engines, cylinder heads, gear boxes, propeller blades.

29. What is carbonitriding?

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

30. Explain super alloys.

Super alloys is a general term used to describe the nickel base and cobolt base alloys which have been developed for use at elevated temperatures

31. What are the influences of other elements on carbon steel?

S.No.	ELEMENTS	INFLUENCES
1.	Silicon	It is a powerful graphitizer. Excess results in breakdown of cementite. It increases the harden ability.
2.	Sulphur	It combines with iron and forms ferrous sulphide [FeS] It improves the machinability and lowers the strength.
3.	Phosphorus	It makes the steel brittle and improves the machinablity. It improves the fluidity of casting steels.
4.	Manganese	Increases the machinablity and reduces the brittleness. It increases the yield point strength and toughness of steel by forming stable carbide.
5.	Nitrogen	It increases the strength, hardness and machinablity of the steel and decreases the ductility and toughness.

32. Define chilled cast iron?

It is produced by quick cooling of white cast iron. Chilling is carried out by putting cool steel inserts into the moulds. When the molten metal comes in contact with the chill, it gets cooled quickly and a hard surface is formed. Typical applications are jaw crusher plates, running surface of rail carriage wheels.

33. Explain the effect of following Alloying Materials on steel.

MATERIALS	EFFECTS
Carbon	Increase strength, hardness, wear resistance with increase in carbon and

	decreases ductility and weldability.
Silicon	Increases hardenability, Removes oxygen in steel, improves resistance to corrosion and oxidation
Phosphorous	Improves machinabilty
Sulphur	Improves machinabilty and Causes brittleness.
Manganese	Improves strength and ductility, machinability, forms hard carbides, deoxidizer.
Chromium	Increase strength, hardness, wear resistance and corrosion resistance, Forms hard and stable carbides.
Tungsten	Forms hard and stable carbides. Improves machinabilty
Molybdenum	Improves creep resistance, strength, toughness, inhibits grain growth and forms hard carbides.

34. Write the constitution of Stainless steel.

18:8 stainless steel [18.0% chromium and 8% nickel]

18:10:3 [18%CHROMIUM, 10% Nickel and 3% molybdenum).

35. Describe HSLA? Where it is used?

High strength low alloy is called as HSLA. This term is used to describe a specific group of steel s that has chemical compositions for desired mechanical properties. They are available in various products, but used as sheet, bar, plate and structural shapes.

36. Explain the important copper alloys and its applications.

ALLOY	COMPOSITION	APPLICATION
Admiralty brass	29% zinc, 1% tin and 70%copper	Bearing material.
Brazing Brass	50% zinc, 50% copper	Brazing purpose
Admiralty Gun metal	88% copper, 5% tin, 5% tin and 2% zinc.	Used for marine work
Leaded Gun metal	85% copper , 5% tin, 55 zinc and 55 lead.	Bearings.

37. Briefly explain cupronickel.

An alloy of 10% and 30% nickel, 1-2% iron and 2% manganese with copper is called as cupronickel. They have better corrosion resistance and erosion resistance than other alloys in sea water.

38. Write some important bearing alloys and its compositions.

ALLOY COMPOSITION	APPLICATIONS
White metal alloys[babbits]	Electricmotors, Turbines,blowers.
Copper lead alloys20-40% lead.	Connecting rods and main bearings.
Bronze bearing alloys	Bearing in machine tools, home appliances, farm machinery and pumps
Porous metal bearings 90% copper, 10% tin	Machine tools, business machines, farm equipments

39. What is precipitation strengthening?

In case of some super saturated sold solutions, there is an increase in hardness with time at room temperature after heating to slightly higher temperature. This type of hardening is called precipitation or age hardening.

PART-B:

1. What are the main classifications of stainless steel? Explain them.
2. Discuss the different types of stainless steel making reference to approximate composition, structure heat treatment.

3. Give typical application for each of the main categories of stainless steel.
4. Write an engineering brief (composition, heat treatment, properties) about the following steels: [a] Tool steel [b] HSLA steel [c] Maraging steels [d] Spring Steel [e] TRIP steel
5. Explain principle characteristics of cast iron and explain the factors which affect the structure of cast iron.
6. Give the classification of steels. Explain them.
7. Describe the properties and application of low medium and high carbon steels.
8. What is an alloy steels? How are alloy steels classified? Explain them.
9. Discuss the composition properties and typical application of any four copper alloys.
10. Explain the composition properties and typical application of some aluminium alloy?
11. What are the effects of ageing temperature and time on the properties of alloy?
12. Summaries the effect of the flowing elements as alloying additions to steel;
    [a] manganese [b] silicon [c] chromium [d] vanadium [e] Titanium
13. Discuss any two copper base alloys, giving their properties and applications.
14. Enumerate the composition and properties of malleable and white cast iron.
15. What is precipitation hardening? Illustrate with an example.
16. Enumerate the composition and applications of following alloys (i) Cupronickel (ii) Bronze (iii) Bearing Alloy.
17. State the effects of following alloying elements on steel (i) Chromium (ii) Molybdenum. Also state any three objectives of adding alloying elements on steel.
18. Using the Al-Cu alloy system as an example, explain the concept of precipitation heat treatment.
19. Explain the purpose of alloying steels with suitable examples from industrial applications.
20. Why copper is a suitable material for automobile radiators? Explain.
21. What are the outstanding properties of cupronickel alloys?

UNIT- IV / NON-METALLIC MATERIALS

PART-A:

1. Define the term polymer?

   The term polymer is derived from the two greek words poly[means many] meros[means unit] thus polymers are composed of a large number of repeting units [small molecules] called monomers
2. What are synthetic polymers?

   Polyethylene, polystyrene, nylon, terylene, dacron, etc are synthetic polymers and are termed under plastic, fibres and elastomers.
3. Explain condensation polymerization.

   Condensation polymerization is the formation of polymers by stepwise intermolecular chemical reactions that normally involve more than one monomer speices.
4. How are polymers classified?

   Polymers are classified according to the mechanical behavior at elevated temperatures as
   1. Thermoplastics (or thermoplastic polymers) 2.Thermosets (or thermosetting polymers)
   3. Elastomers.
5. Explain the application of types of thermoplastics.

   1. Polyvinyl chloride (PVC) and polystyrene used in articles such as plastic wall and floor tile.
   2. Polystyrene-Flouresent light reflectors.
   3. Polymethyl Methacrylate –Plastic lenses.
6. What is the characteristic of thermoplastics?

Thermoplastics (or) Thermoplastic polymers soften when heated (and eventually liquify) and harden when cooled. They can be repeatedly moulded and remoulded to the desired shapes.

7. Define plastics.

A plastic is defined as an organic polymer, which can be moulded into any desired shape and size with the help of heat, pressure (or)both. The plastic, in its liquid form, is known as resin.

8. What are the thermosetting polymers?

1. Epoxies.2.Phenolics.3.Polyesters.4Urea formaldehyde.5.Melamine formaldehyde.

9. Define rubber.

The rubber may be defined as an organic polymer ,which elongates on stretching and regains its original shape after the removal of the stress.

10. Explain ceramics.

Ceramic material are defined as those containing phase that are compounds of metallic and non-metallic elements .In short ,ceramics are inorganic, non-metallic materials.
Ex: Stone, brick, concrete, clay, glass, vitreous enamel and refractories. Majority of these are composed of silicates.

11. Name two refractory materials.

The ceramics materials such as magnesia (with melting point of $2880^{\upsilon}C$) and alumnia (with melting point of $2040^{\upsilon}C$) are excellent choice of refractory materials.

12. What are applications of poly **styrene's**?

1. Packaging 2. Insulation foams. 3. Lighting panels. 4. Egg boxes. 5. Walls Tiles. 6. Battery cases.

13. Define Slip and Twinning types of deformation.

Slip deformation is defined as the sliding of blocks of crawl over one another along definite crystallographic planes called slip planes, Whereas Twinning deformation is atoms in a part of crystal subjected to stress, and rearranging themselves so that one part of crystal becomes a mirror image of another part.

14. List any four attractive characteristics of polymers.

Low density, Good thermal and electrical insulation properties, High resistance to chemical attack, Ease of fabrication, relatively low cost

15. What is meant by isomerism?

Isomerism is a phenomenon wherein different atomic configurations are possible for the same configuration

16. Differentiate commodity plastics with engineering plastics.

The plastics which are not generally used for engineering applications are known as commodity plastics. The plastics which are used in engineering applications are known as engineering plastics.

17. Name any four commodity plastics and engineering plastics.

Commodity plastics: Polyethylene, Polypropylene, Polystyrene, Polyvinyl chloride
Engineering plastics: Ethenic, Polyamides, Cellulosics, Acetals

18. What are the sources of raw materials for plastics?

Animal and vegetable by products, Coal by products, Petroleum by products 19. Write short notes on nylons.

Nylons also known as Polyamides are the product of condensation reaction between an amine and an organic acid

20. Describe engineering ceramics.

Engineering ceramics are also known as technical/industrial ceramics, are those

ceramics that are specially used for engineering applications or in industries 21. Name any four engineering ceramics.

Alumina, Silicon carbide, Silicon nitride, Sialons

22. What are composites?

Composites are produced when two are more materials are joined to give a combination of properties that cannot be attained in the original materials.

23. Explain the role of matrix material in a composite.

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

24. Write the general mechanical properties of ceramics.

Ceramics are strong, hard and brittle, they are good thermal and electrical insulators, they have high compressive strength but are weak in tension.

25. What do you meant by copolymers?

Copolymers are polymers which are obtained by adding different types of monomers 26. How are refractories classified?

Fire clay refractories, Silica refractories, Basic refractories, Special refractories

27. Give two examples of particulate reinforced metal matrix composites.

Sintered Aluminium Powder (Al/Al2O3), Cermet,

28. Explain Cermets and its applications.

Ceramic metal composite containing between 80 to 90% of ceramics are known as Cermets. Applications: Cutting tools, Slip gauge, wire drawing dies, rocket motor and jet engine parts.

29. What are the constituents of composites?

Composites are composed of two phases: Matrix phase, Dispersed phase

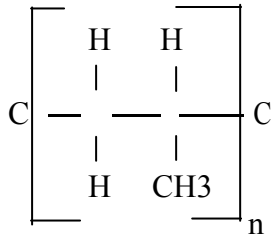
30. Name any four engineering polymers. Ethenic,

Polyamids, Silicones, Polyimides.

31. What is polymer?

Polymer interchangeably called as plastic materials made by polymerization with repeated molecules that contains as an essential ingredient an organic substance of large molecular weight, is solid in its finished state.

32. Draw the structure of Polypropylene [PP] and write the applications



Applications: Luggage, Battery cases, Tool Boxes, Filaments

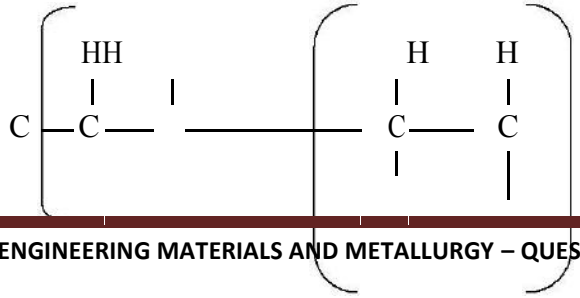
33. Write the properties of Polystyrene and its applications.

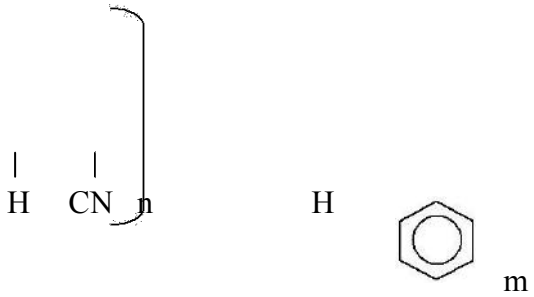
Excellent moldability, Poor impact strength, Melting Point 115^0C, It can be made into rigid foam. Applications: Plastic tableware, Food containers and toys

34. Explain ABS. Draw its molecule Structure.

ABS stands for Acrylonitrile Butadiene Styrene.

Properties: High Impact Strength, Heat resistance, Environmental Resistance

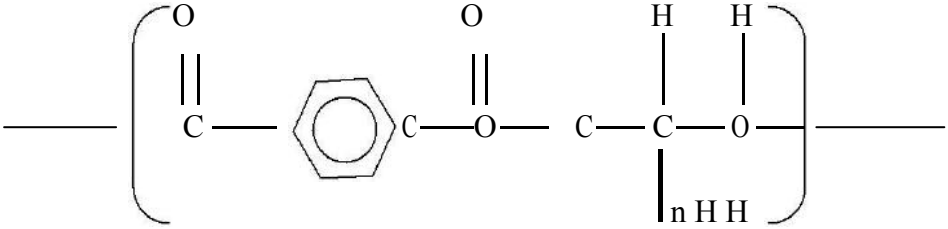




Acrylonitrile Butadiene Styrene (ABS)

35. Define PET. Draw its Molecule Structure. What are the applications?

PET [PolyEthylene Terephthalate] is a thermo plastic Polyester.



Polyethylene Terephthalate [PET]

Applications: Beverage Bottles, Auto parts, Gears, Cams, Films for photography, Packaging, Fibres and Clothing, Tire Reinforcement,

36. Describe Torlon.

Polyamide-imide is called as Torlon. It consists of amide and imide group linkages with nitrogen bond. They are used in higher temperature load applications, high temperature wire varnishes, glass, fibers.

37. What is carbon- carbon composite?

In the carbon – carbon composite the matrix is carbon-graphite and the reinforcement is carbon fibers. These composites are used for light weight coupled with high temperature applications

38. Name some industrial items made from carbon-graphite.

Nose piece and leading edges of the wings on the space shuttle, less exotic applications, brake linings for large aircraft.

39. Explain vitrification. When is it used?

Vitrification is a densification process in ceramic manufacturing. This done by heating the formed component to higher temperature below its melting point. At this temperature atoms diffuses and forms a hard structure.

40. What is the effect of porosity in ceramics? How can porosity be reduced?

Porosity reduces the strength of the ceramics. Porosity can be reduced by using proper binders, Vitrified at higher Temperatures, fine grain ceramic particles.

PART-B:

1. Describe the difference between thermoplastics and thermosetting plastics.
2. Write on engineering brief about the flowing thermoplastics;
   [a] polyethylene[b] Polyvinyl chloride [c] Acetyl [d] polyamides
3. List the properties and typical application of the following thermoplastics
   [a] PTFE [b] PMMA[c] PET [d] PEEK [e] PE
4. What are ceramics? List and briefly explain five important properties of ceramics that make them useful engineering materials. Explain the main classification of ceramic materials.
5. Discuss the properties and typical application of the following engineering ceramics?
   [a] AL2O3 [b] SIC [c] SI3N4 [d] PSN [e] Silons
6. List the advantages and limitations and application of composite materials.
7. Explain the difference between commodity plastics and engineering plastics.
8. Describe the molecular structures properties and application of the following polymers.

[a] polyvinyl chloride[PVC] [b] polystyrene[PS] [C] Polyethylene terephthalate[PET] [d] polycarbonate[PC]

9. Give a detailed account on:

[a] urea formaldehyde [b] fibre rain forced plastics [c] cellulose nitrate 10. Explain the following terms with respect to polymers (1) Mechanical behavior (2) Thermal behaviour (3) Electrical behaviour.

11. What are the special properties of plastics that make them suitable for engineering applications? **Describe the concept of 'Co-polymerization'.**
12. List the important engineering ceramics and its applications. Discuss the properties and applications of Si_3N_4 and S_iC.
13. Discuss the structure and applications of any four thermoplastic and any four thermoset plastic materials.
14. Discuss the properties and applications of the following four ceramics.
    (1) Silica (2) Zirconia (3) S_iC (4) Cubic boron nitride.
15. What are the fibre reinforced plastics? Name any four fibres and their matrix material.
16. Write short notes on: (i) Ceramics (ii) Urea Formaldehyde (iii) Phenol Formaldehyde.
17. Explain the properties and applications of the following poymers and discuss anyone fabrication methods of polymers. (I) PMMA (II) PP (III) ABS and (IV) Glass.
18. List the important engineering ceramic materials and discuss its general applications of ceramic materials in various engineering fields. What are the advantages and disadvantages of ceramics?
19. Describe the terms: (1) Linear Polymer (2) Branched Polymer (3) Chain Stiffening (4) Cross linked Polymer.
20. Describe cemented carbide and how they are made? Explain the step by step process.
21. What is polymerization? Describe addition polymerization and condensation polymerization.
22. How plastic materials are classified? Explain each classification.

UNIT- V / MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS

PART-A:

1. Explain twinning.
   Twinning is the two plastic deformation which takes place along the planes due to a set of forces acting on a given metal. The two planes are usually parallel to each other and are called the twin planes. Here each atom moves only a fraction of an inter –atomic distance relative to its neighbours.
2. Define fracture.
   Fracture can be defined as the breaking up (or) separation of a solid into two (or) more parts when subjected to an external load.Fracture can occur as the end result of extensive plastic deformation (or)as the end result of fatigue in a part of the material.
3. What is brittle fracture?
   A brittle fracture can be defined as a fracture which is the result of intense localized plastic deformation and very rapid crack propagation. It consists of destroying the interatomic bonds with normal stresses.
4. Define ductile fracture.
   A ductile fracture can be defined as a fracture which is the result of intense localised plastic deformation of the metal at the tip of the crack .At elevated temperatures all fractures tend to become ductile because slip can occur more easily.
5. Explain the fatigue fracture.

Fatigue fracture is the fracture that occur under repeatedly applied fatigue stresses. This fractures occurs at a stress well below the tensile strength of the materials.

6. Define creep fracture.

Creep fractures is seen to take place by two ways: Sliding of grain boundaries, Movement of dislocations from one slip to another by climbing.

7. What is the use of tensile test?

The tensile test is used to determine the mechanical properties of material. It also gives information on how material behave under tensile loading condition.

8. Define elastic limit.

The elastic limit can be defined as the greatest amount of stress that the material can withstand and still return to its original state when the load is removed .

9. What is proportional limit?

Proportional limit is the stress at which stress-strain curve deviates from linearity.

10. Explain the use of Izod test.

The Izod test is the impact test which is used to determine the impact strength of a material.

11. Define endurance limit in fatigue test.

Endurance limit is defined as the value of stress below which the material will not fail when it is loaded for infinite number of cycles.

12. What properties are determined from tension testing of metallic products?

(1) Limit of proportionality ,(2)Yield strength, (3) Maximum tensile strength, (4) Breaking strength, (5) Percentage elongation, and (6) Modulus of elasticity.

13. Differentiate between Fatigue and Creep tests.

Fatigue test s are to test the metal load carrying capacity of repeated load and fluctuating loads. The Creep test on metals are to find the metal under steady load.

14. Explain the mechanical properties of materials.

Mechanical properties are whose characteristics of material that describe its behavior under the action of external forces.

15. Distinguish between elasticity and plasticity.

- Elasticity is the property of the material by virtue of which it is able to retain its original shape and size after the removal of load.
- Plasticity is the property of the material by virtue of which a permanent deformation takes place whenever it is subjected to the action of external forces.

16. What are the factors affecting mechanical properties?

Grain size, Heat treatment, Atmospheric exposure, Low and high temperature.

17. Define the terms Slip and Twinning.

- Slip may be defined as the sliding of blocks of the crystal over one another along definite crytsollographic planes called Slip planes.
- 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.

18. Differentiate between ductility and malibility.

- Ductility is the property of the material by virtue of which it can be drawn into wires before rupture takes place.
- Malleability is the property of the material by virtue of which it can withstand deformation under compression without rupture.

19. Define the terms brittleness and hardness.

- Brittleness is the property of the material by virtue of which it can withstand deformation under compression without rupture.
- Hardness is the property of the material by virtue of which it is able to resist

abrasive indentation, machining, scratching.

20. What do you mean by toughness and stiffness?

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

21. List any four technological properties of metals.

Machinability, Castability, Weldability,Formability or Workability. 22. What is meant by fracture?

Fracture is the mechanical failure of the material which will produce the separation or fragmentation of a solid into two or more parts under the action of stresses.

23. List the different types of fracture in a material. Brittle Fracture, Ductile Fracture, Fatigue Fracture, Creep Fracture.

24. What are the factors affecting the creep?

Grain, Thermal stability of the micro structure, Chemical reactions, Prior strain.

25. List some important destructive tests carried out on a material.

Tensile test, Impact test, Fatigue test, Bend test, Torsion test, Creep test.

26. Define the term notch sensitivity.

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

27. 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 no. of cycles.

28. What are the properties are determined from tension testing of metallic products?

Limit of proportionality, Yield strength, Maximum tensile strength, Breaking strength, Percentage elongation and Modulus of elasticity

29. 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, **young's** modulus, etc are calculated.

30. Why are impact specimens notched?

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 normal ductile materials to behave the like a brittle material in the presence of notches.

31. 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.

32. Explain in detail Creep.

The creep is defined as the property of material by virtue of which it deforms continuously under a steady load. Engineering materials are subjected to a constant stress for prolonged time. This would increase the length even though the stress remains constant. This phenomenon of slow and progressive deformation of a material with time at constant stress is called creep.

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

Shock or impact load, Static load Random load, Repeated or reversed load. 34. Generally creep rate in the secondary creep region is a constant with time. Why?

At this stage a balance exists between the rate of work hardening and rate of softening because of recovery or recrystallization. 35. **What is "Resilience"?**

It is the property of material which enables it to store energy and resist shock and impact. It is measured by the amount of energy that can be stored in a body up to the elastic limit.

36. Explain the term Fatigue.

Components with alternating loading [alternate loads of compression and tension lowers the fracture stress of the material. Such a premature failure is called as Fatigue.

37. Define ductile fracture.

In ductile materials fracture takes place after the considerable amount of plastic deformation. Fracture with considerable amount of plastic deformation is known as ductile deformation.

38. What is critical resolved shear stress?

All metals of similar crystal structure slip on the same crystallographic planes and in the same crystallographic directions. Slip occurs when the shear stresses resolved along these planes reaches a certain value. This is called as critical resolved stress.

39. Define endurance limit(SN).

Materials subjected to cyclic loads (Alternative) the maximum stress amplititude which can be sustained for a given number of cycles (N) is known as endurance limit SN

40. Write the factors which contribute to the onset of fatigue failure.

Corrosion, Surface finish, Temperature, Micro-structure of an alloy, Residual stresses, Stress concentration, Heat treatment.

41. Differentiate between Brittle fracture and ductile fracture.

Sl.No	DUCTILE FRACTURE	BRITTLE FRACTURE
1.	Material fractures after plastic deformation and slow propagation of crack	Material fractures with very little or no plastic deformation .
2.	Fractured surfaces are dull or fibrous in appearance	The fractured surfaces are crystalline in appearance.
3.	Percentage elongation is about 30% before fracture occurs.	Percentage of elongation is approx.0.5%
4.	There is reduction in cross sectional area of test piece	No change in the cross sectional area.
5.	Fracture takes place after necking with little sound.	Fracture occurs rapidly often accompanied by loud noice.

42. Write the difference between Slip and Twinning.

Sl.No	SLIP	TWINNING
1.	All Atoms in one block move the same distance	Atoms in each successive plane within a block move different distances.
2.	Under Microscope: Slip appears as thin lines.	Twinning appears as broad lines or bands.
3.	There is very little change in lattice orientation, of slipped region.	There is a markedly different lattice orientation in the twinned region.
4.	Slip requires less shear stress than twinning	Requires higher shear stress than slip

43. What are the factors, which affect the creep resistant materials?

1. Pre-strains increase the creep rate.
2. Substitutional solid solution usually improves creep résistance.
3. Precipitation and dispersion hardening improves the creep.
4. Grain size and grain boundaries.

44. Describe characteristics of creep resistant material.

- Instantaneous extension produced as soon as the test load is applied.
- Primary or transient creep stage during which further work-hardening occurs.
- A steady state or secondary creep during which the work-hardening effect of plastic deformation is balanced
- A period of acceleration or tertiary creep leading to eventual fracture.

45. What are the advantages of pyramid indenter over other indenters?

    One can measure the square or diamond- shaped impression easily as compared with a circular impression. The ends of the diagonal are much sharper under the microscope than the opposite sides of a circle

PART-B:

1. Describe a Brinell hardness test to determine the hardness of a metal.
2. Explain the procedure for performing the Rockwell test.
3. Explain the Izod test and charpy test to determine the impact strength of a material.
4. Write an engineering brief about the creep test?
5. Explain the mechanism of plastic deformation of metals by slip and twinning?
6. Describe the characteristics of ductile fracture and brittle fracture.
7. Explain the testing procedure for Vickers hardness testing?
8. Explain the two modes of plastic deformation in metals with neat sketches?
9. What is brittle fracture? Explain the Griffith theory on brittle fracture and deduce an expression for the critical stress required to propagate a crack simultaneously in a brittle materials?
10. Critically compares the deformation by slip and twinning?
11. Explain the types of impact tests and how ductile to brittle transition is occur with diagram.
12. Draw the engineering stress – strain curve for mild steel, aluminium and cast iron. Discuss the tensile test and different mechanical properties obtained in tensile testing. Write a short note on compression test.
13. Discuss fatigue test for a metallic material. What is S-N diagram?
14. What are the different types of fractures in metallic materials? Give the important features of these fractured surfaces. What is the use of this study?
15. What are the properties measured from tensile testing and write their engineering significance? Draw the stress and strain curve for aluminium, cast iron and low carbon steel.
16. Describe fatigue testing and methods for improving fatigue strength of the components. Draw the S-N curve for aluminium and titanium.
17. Draw creep curve and explain the different stages of creep damage.
18. Draw S-N curve for ferrous and non-ferrous metals and explain how endurance strength can be determined. Also discuss the factors that affect the fatigue life.

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Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 77216

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Fourth Semester

Mechanical Engineering

ME 6403 — ENGINEERING MATERIALS AND METALLURGY

(Common to Automobile Engineering, Mechanical and Automation Engineering and also common to Third Semester Manufacturing Engineering)

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Name and explain the standard rule for the formation of substitutional type of solid solutions.

2. Name the system and sketch the labeled ideal binary phase diagrams for the system where the components are completely soluble in liquid and partially soluble in solid states.

3. Differentiate annealing and normalizing treatments.

4. "Austempering is different from other hardening treatments". Explain the statement.

5. What is HSLA? Explain with respect to composition, properties and application.

6. Explain briefly the effect of ferrite stabilizer on the eutectoid temperature and composition.

7. Differentiate thermosetting and thermoplastic polymers.

8. What is meant by metal matrix composites? Give one example each to matrix material and reinforcements used.

9. Draw a typical creep curve for ductile metal and explain the regions.

10. Draw a typical load versus percentage elongation curve for ductile material and explain the tensile properties.

PART B — (5 × 16 = 80 marks)

11. (a) Neatly sketch labeled Iron-Carbon equilibrium diagram. Name, write and explain the reactions involved.

Or

(b) Explain the procedural steps for constructing the binary phase diagram where the components show complete liquid and solid solubility. Draw the labeled diagram and name the system. Give one example for the alloy system showing above mentioned behavior.

12. (a) Draw a neat sketch of the Isothermal Transformation diagram for Eutectoid steel and explain the constructional procedure. Label all the salient features on it. Superimpose on it a cooling curve to obtain bainitic phase.

Or

(b) Differentiate hardness and hardenability. Explain with a neat sketch, the procedure to plot the hardenability curves for eutectoid steel in Jominy End Quench Test.

13. (a) Classify Stainless steel and tool steels and explain the following :

(i) Maraging steel (5)

(ii) Spheroidal graphite iron (5)

(iii) High speed steel in terms of composition, property and use. (6)

Or

(b) With part of phase diagram and relevant graphs explain precipitation hardening treatment of Al-Cu alloy.

14. (a) Name, explain the properties and application of any eight varieties of polymers used as engineering materials.

Or

(b) Name, explain the properties and application of any four types of ceramics.

15. (a) Name and explain the different types of hardness tests with respect to the procedure, relative advantages and disadvantages.

Or

(b) With geometry and arrangement of impact test specimens explain Charpy and Izod test with relative advantages and disadvantages.

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Question Paper Code : 80658

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Third Semester

Manufacturing Engineering

ME 6403 — ENGINEERING MATERIALS AND METALLURGY

(Common to Fourth Semester Automobile Engineering, Mechanical and Automation Engineering and Mechanical Engineering)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define the term solid solutions.
2. How will you classify steels?
3. When will you prefer annealing?
4. Define the term Cementite.
5. List the important properties of HSLA.
6. What are Bronzes? List the uses of Bronzes.
7. Define the term degree of polymerization.
8. State any four applications of Bakelite.
9. Define the term Fatigue.
10. List any four mechanical testing methods of metals.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Explain the various micro constituents present in steel. (8)

(ii) With a neat sketch, label the reactions of $Fe - Fe_3C$ diagram. (5)

Or

(b) (i) Discuss the classification of cast iron and draw its microstructure. (9)

(ii) State the properties and applications of plain carbon steel. (4)

12. (a) (i) Distinguish between annealing and tempering. (4)

(ii) Explain in detail the flame and induction hardening with neat sketches. (9)

Or

(b) Explain the principle and procedure of Jominy end quench test with a diagram. Also sketch the graph hardness Vs distance from quenched end. (13)

13. (a) (i) With a neat sketch, explain precipitations hardening. (8)

(ii) State the compositions, properties and uses of bearing alloys. (5)

Or

(b) Write short notes on the following :

(i) Maraging steels (4)

(ii) SS (5)

(iii) HSS. (4)

14. (a) Explain the following.

(i) Engineering ceramics. (5)

(ii) Formaldehydes (4)

(iii) PMMA. (4)

Or

(b) (i) Explain the Engineering polymers in detail. (7)

(ii) State the properties and uses of reinforced composites. (6)

15. (a) (i) What are the different hardness tests performed in metallic natural? Specify the indenter and hardness measurement scale of the same. (4)

(ii) Explain the procedure of tensile test for metals. (9)

Or

(b) (i) Explain the mechanism of plastic deformation with suitable illustrations. (8)

(ii) Discuss about the creep test with a typical creep curve. (5)

PART C — (1 × 15 = 15 marks)

16. (a) Discuss the effects and characteristics of alloying elements in steel. (15)

Or

(b) Name the suitable alloys, polymers and ceramics for manufacturing the following items. (15)

(i) Bush

(ii) Furnaces heating element

(iii) Lathe bed

(iv) Coins

(v) Girders for Airship

(vi) Big end bearing

(vii) Turbine blades

(viii) Conduit pipes

(ix) Knobs

(x) Windshields

(xi) Touch screens

(xii) Furnace linings

(xiii) Grinding (abrasive) wheels

(xiv) Coatings on cutting inserts

(xv) Cutting inserts for ferrous alloys.

PART – B (5×13=65 Marks)

11. a) i) Draw Iron-Iron carbide phase diagram, name the various field, line and reactions. (10)

ii) Find the wt. fraction of ferrite and cementite of eutectoid steel. (3)

(OR)

b) Compare the microstructure and properties of various cast iron.

12. a) Brief on hardening and tempering of steel.

(OR)

b) Compare different types of case hardening process.

13. a) Brief on the influence of alloying elements in steel under classification of α and γ stabilisers.

(OR)

b) i) What are the classification of aluminium alloys and state the applications of any THREE alloy. (7)

ii) Brief on the mechanism of ageing treatment of Al-Cu alloy. (6)

14. a) i) Classify composite materials based on the type of reinforcement and state an example of each. (7)

ii) State the properties and applications of two ceramics from the list : PSZ, Si_3N_4, Al_2O_3 and SIALON. (6)

(OR)

b) i) List properties and applications of any three type of ceramics. (7)

ii) Brief on properties and applications of any two polymers from the list.

PP, PC, PEEK, ABS and PS. (6)

15. a) i) Compare slip and twinning. (4)

ii) Draw a typical creep curve and brief on the mechanism. (9)

(OR)

b) i) Draw a typical tensile test curve of metallic sample, mark the different points/ regions that represent different mechanical properties. (4)

ii) Draw a typical S-N curve of fatigue testing and brief on the mechanism. (9)

PART – C (1×15=15 Marks)

16. a) i) Explain why certain alloys are heat treatable, some are castable and other wrought ? (8)

ii) Suggest an material of choice for application as orthopaedic implant (or) brake drum of automobile. Justify your choice, based on the properties of materials and method of production. (7)

(OR)

b) Compare and contrast Brinell, Vickers and Rockwell hardness test technique, advantages and disadvantages. 15

16/11/17 AN

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 50863

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017
Third/Fourth Semester
Mechanical Engineering
ME 6403 – ENGINEERING MATERIALS AND METALLURGY
(Common to Automobile Engineering/Manufacturing Engineering/Mechanical and Automation Engineering)
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions.

PART – A (10×2=20 Marks)

1. Draw a typical isomorphous phase diagram.
2. Why carbon content in austenite is higher than ferrite ?
3. What is difference between stress relief and recrystallization heat treatment process ?
4. Which has higher critical cooling rate: eutectoid steel or hypereutectoid steel ? Justify.
5. Which type of stainless steel is non magnetic ?
6. What is the role of boron in steel alloying ?
7. What are outstanding properties of PTFE ?
8. List the typical applications of SiC.
9. What are the characteristic features of brittle fracture ?
10. State hardness whether corresponds to ultimate tensile strength or yield strength ? Justify ?

27 Nov 2017

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 72144

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Third/Fourth Semester

Mechanical Engineering

ME 6403 – ENGINEERING MATERIALS AND METALLURGY

(Common to Automobile Engineering, Manufacturing Engineering, Mechanical and Automation Engineering)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the types of solid solutions?
2. Why is carbon solubility more in Austenite?
3. What are the principal advantages of austempering over conventional quenching and temper method?
4. Mention few applications of induction hardening system.
5. What are the effects of adding Si in steels?
6. Differentiate Brass from Bronze.
7. Differentiate between composite and an alloy.
8. Write short notes on PET.
9. Differentiate between ductile and brittle fracture.
10. What is the difference between HRB and HRC (Rockwell 'B' scale and 'C' scale)?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Explain the following invariant reactions with reference to a phase diagram:

(1) Eutectic reaction, (2) Eutectoid reaction. (6)

(ii) Draw iron-iron carbide phase diagram and mark on it all salient temperatures and composition fields. (7)

Or

(b) What are the micro-constituents of iron-carbon alloys? Explain the general characteristic of each. (13)

12. (a) Compare and contrast the process of full annealing, stress relief annealing, recrystallization annealing, and spheroidise annealing. (13)

Or

(b) Define hardenability. Describe the test procedure to determine hardenability of steel. (13)

13. (a) Discuss the influence of various alloying elements in steel. (13)

Or

(b) Discuss the composition, Properties, and typical applications of any four copper alloys. (13)

14. (a) What is meant by 'polymer'? Discuss the properties, applications and chemical structure of any four types of polymers. (13)

Or

(b) Give any two important properties of ceramics. Write short notes on any four ceramic materials. (13)

15. (a) Discuss the mechanisms of slip and twinning in detail. (13)

Or

(b) Sketch and describe the following hardness tests. (i) Brinell (ii) Vickers. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Suggest a suitable material for the gear used in the gearbox of an automobile. Since the surface of the gear is subjected to constant wear, suggest and discuss any three methods to improve its wear resistance property. (15)

Or

(b) It is required to do turning operation of mild steel shaft on a lathe machine. Suggest and discuss suitable material for the single point cutting tool for this purpose. (15)

16/05/18 FN

Reg. No. :

Question Paper Code : 41394

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018
Third/Fourth Semester
Mechanical Engineering
ME 6403 – ENGINEERING MATERIALS AND METALLURGY
(Common to Automobile Engineering, Manufacturing Engineering and Mechanical and Automation Engineering)
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL the questions.

PART – A (10×2=20 Marks)

1. What is an equilibrium phase diagram ?
2. Define Cementite and Pearlite in Fe-C alloys.
3. What are the needs of annealing process ?
4. What are the factors should be considered while selecting a quenching medium ?
5. What are three primary groups of plain carbon steels ?
6. What is meant by precipitation hardening ?
7. Distinguish between thermoplastics and thermosetting plastics.
8. What is meant by PSZ ?
9. Differentiate between Brittle and ductile fracture.
10. What are the factors affecting fatigue ?

PART – B (5×13=65 Marks)

11. a) Draw the Iron-Carbon equilibrium phase diagram and discuss the different phases that takes place in it. (13)

(OR)

b) Discuss the classification, properties and application of steel. (13)

12. a) What is hardenability ? Describe a test that is used for determination of hardenability of steel. (13)

(OR)

b) What is case hardening ? Explain in details the carburizing processes. (13)

13. a) Write a short notes on :

i) HSLA steel
ii) Maraging steel
iii) Stainless steel. (5+4+4)

(OR)

b) Discuss the characteristics of copper and its alloys, their properties and applications. (13)

14. a) Explain the properties and applications of the following polymer materials.

i) Polystyrene
ii) Polyethylene
iii) Polypropylene. (5+4+4)

(OR)

b) How engineering ceramics are classified ? Explain their properties and applications. (13)

15. a) Explain testing procedure for Rockwell hardness test. (13)

(OR)

b) Explain the testing procedure of Tensile Test of Material. (13)

PART – C (1×15=15 Marks)

16. a) What type of failure is occurring when a circular rod is subjected to a constant load at high temperature ? Explain the testing procedure. (15)

(OR)

b) What are the different types of cast irons ? Explain with neat sketch of the microstructure of any four types of cast irons. Give application for each. (15)