



WINTER– 14 EXAMINATION

Subject Code: **17303(MEM)**

Model Answer

Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

1. Attempt any ten:

[20 MARKS]

a) Define ductility and hardness. [2 MARKS , 1 MARK EACH DEFINATION]

Ductility: it is ability of a material by virtue of which it can be drawn in thin wires.

Hardness : it is ability of a material which shows resistance against indentation, penetration and scratches.

b) Define plasticity and elasticity. [2 MARKS, 1 MARK EACH DEFINATION]

Plasticity : It is the property of material by virtue of which it may be permanently deformed when it has been subjected to an externally applied force great enough to exceed the elastic limit.

Elasticity : It is the ability of metal to regain its original shape and size after removal of applied load is known as elasticity.

c) What is metal? How metals are broadly classified? [2 MARKS , 1 MARK FOR DEFINATION, CLASIFICATION 1 MARK .]

Metals: The substances which readily give up electrons to form metallic bonds and conduct electricity are called metals.

Metals are broadly classified as follows.

- i) Ferrous - irons, carbon steels, alloy steels, tool and die steels ,
- ii) Non ferrous – aluminium, copper , and its alloys , titanium alloys etc.



- D) State any two corrosion resistant materials added in alloy steels. [2 MARKS, Any two, 1 MARK EACH]**
Chromium, nickel, copper, molybdenum etc,
- E) Define ferrite. [2 MARKS]**
Ferrite also known as alpha (α) iron is an interstitial solid solution of carbon in α iron with a maximum solubility of 0.008 % at room temp. and 0.025 % at 723⁰C. It is almost pure iron with BCC crystal structure. It is a relatively soft and ductile phase.
- F) Define austenite. [2 MARKS]**
It is an interstitial solid solution of carbon in γ gamma iron (FCC structure). Solubility of C in austenite is 0.8% at 723 ⁰c and this limit increases up to 2 % at 1140 ⁰c. Austenite is stable only above 723 ⁰c. As temperature drops below A₁, it transforms in other phases like ferrite, pearlite, martensite etc. It is soft, ductile, malleable and nonmagnetic.
- G) State the composition of muntz metal. [2 MARKS]**
Muntz metal 60% Cu & 40% Zn
- H) State the composition of gun metal. [2 MARKS]**
10% Sn (tin), 2% Zn, rest Cu (88%)
- I) State the classification of pig iron. [2 MARKS]**
1. Basic pig iron 2. Foundry pig iron 3. ferroalloys
- J) Write the application of wrought iron. [2 MARKS]**
[any four applications ½ mark each]
Wrought iron is used as raw material for refining into steel, which was used mainly to produce swords, cutlery, chisels, axes and other edged tools as well as springs and files. Also used for rivets, nails, horse shoes, timber roof trusses, guard rails, garden furniture, gates etc.
- K) What is nitriding? [2 MARKS]**
Process of heating of alloy steels in contact with nitrogen bearing gas environment to a temperature of 500 to 550 degree centigrade and held for a long period of time (25 to 100 hours) in the furnace. During holding period , there is a chemical reaction in the gas and the free nitrogen atoms are liberated. These atoms penetrate into outer surface of the steel component and combine with alloying elements to form “hard alloy nitride particles” in the outer surface of the steel, due to which outer surface becomes extremely hard and wear resistant.
- L) What is the effect of molybdenum on properties of steel? [2 MARKS, AT LEAST FOUR EFFECTS , ½ MARK EACH]**
Molybdenum (Mo)
- increase hardenability and strength
 - Mo-carbides help increase creep resistance at elevated temps.
 - It reduces temper embrittlement.



- It increases wear and abrasion resistance
- Refines grain size and carbides inhibit grain coarsening.
- It reduces tendency of decarburization.
 - typical application is hot working tools

M) What is the necessity of tempering?

[2 MARKS]

- to relieve internal stresses produced during hardening.
- to reduce hardness.
- to improve ductility and toughness.
- to reduce retained austenite.
- to obtain a spheroidal structure which improves machinability.

N) Define polymer.

[2 MARKS]

Polymers are organic materials having carbon as common element in their makeup.

They have large molecules which are formed by repeated linking (i.e. polymerization) of individual molecules called monomers(single unit).

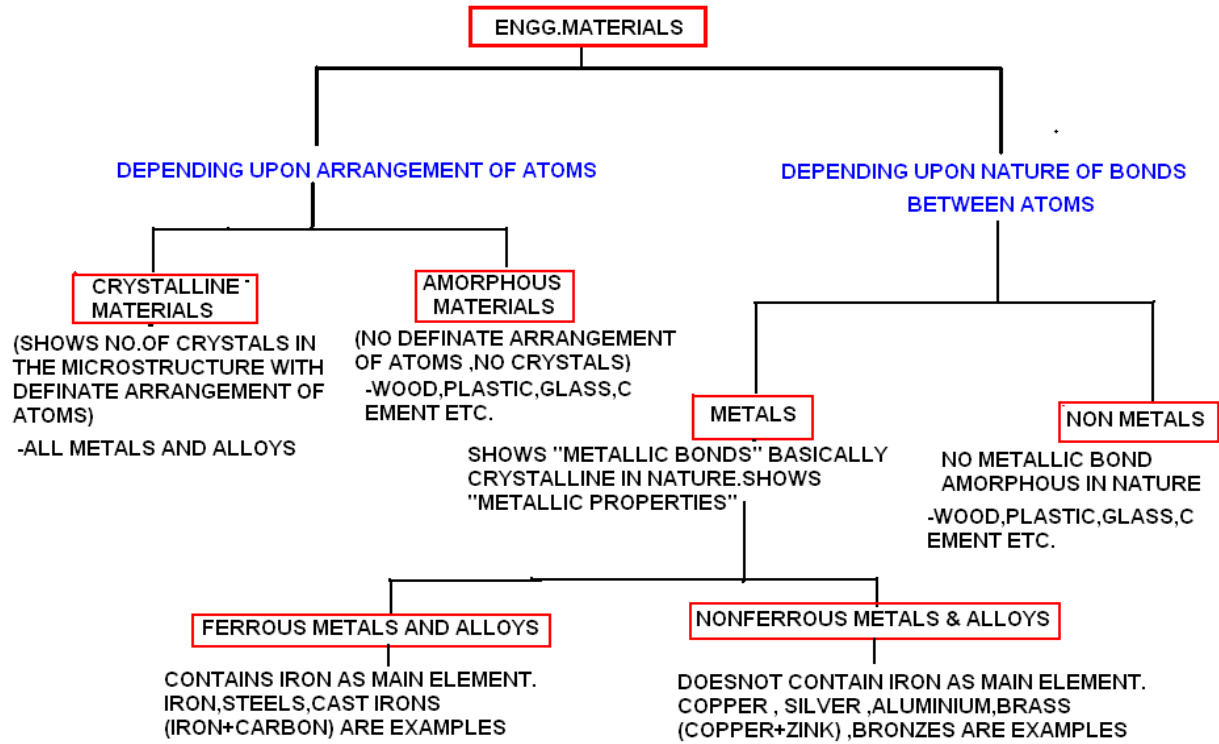
2. Attempt any four :

[16 MARKS]

A. How engineering materials are classified? Give examples of each. [4 MARKS, 1 MARK FOR EACH MATERIAL WITH EXAMPLE]

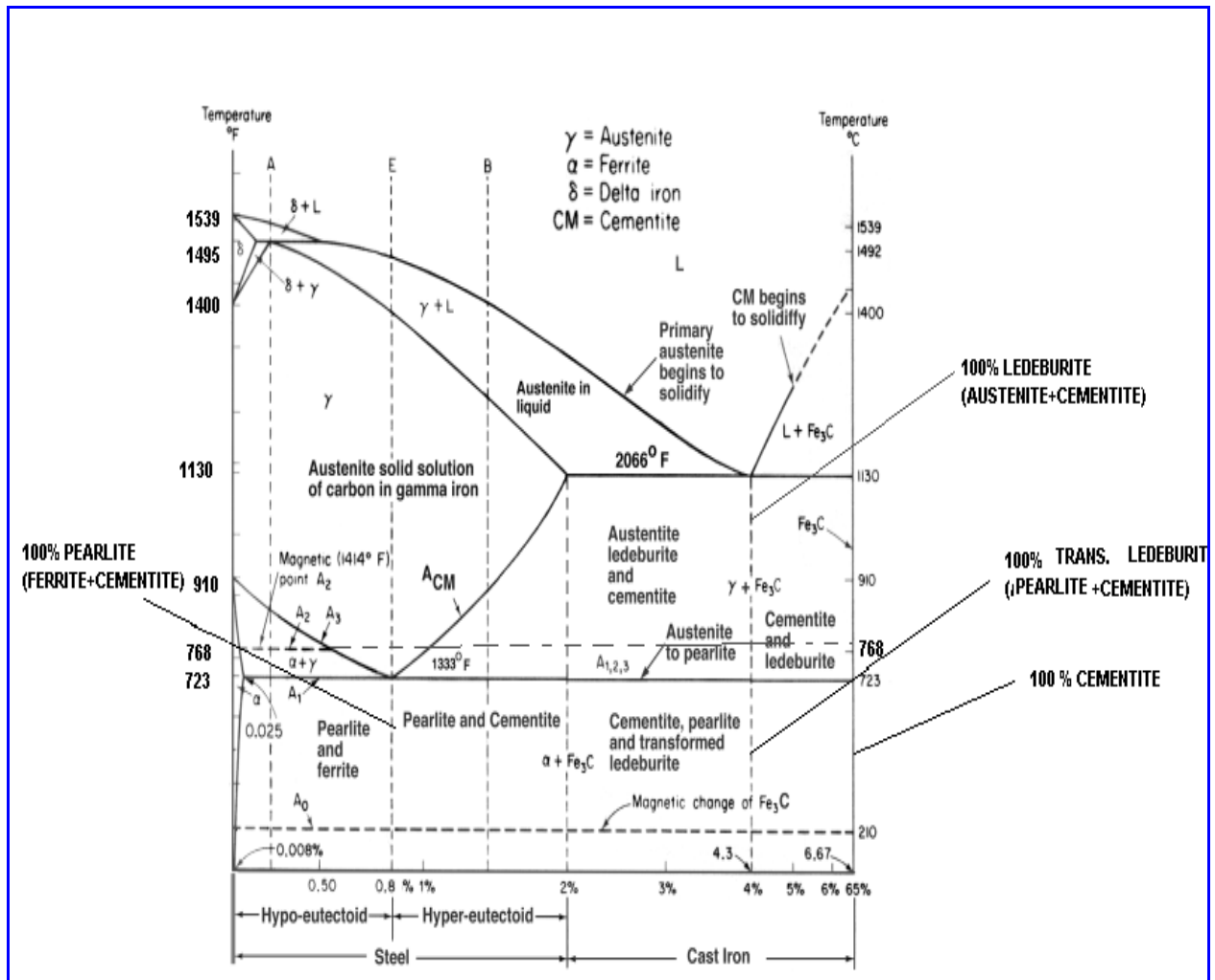
Engineering Materials

1. Metals and alloys (Iron, Copper, Gold, Steel, Brass, Bronze etc)
2. Ceramics (Metal oxides, nitrides, carbides and silicates i.e. Alumina, Sic, Glass, Cement)
3. Polymers (Acrylic, Nylon, PVC, Polyethyiene)
4. Composites (Wood, FRP, Cement concrete Glass reinforced plastics)



B. Draw iron carbide phase diagram and show various phases on it. [4 MARKS]

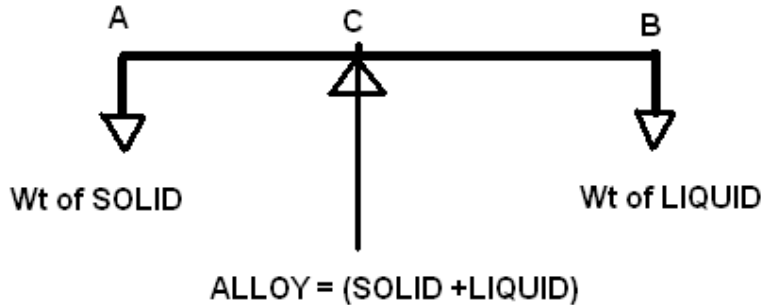
DIAGRAM 3 MARKS, LABEL 1 MARK





C. State and explain lever rule. [4 MARKS, EXPLANATION WITH ANY REACTION CAN BE CONSIDERED.]

Lever Rule: Lever rule is used to calculate proportions of two phases or microconstituents in a two phase region. It has mechanical analogy with lever. Here it is assumed that weights of two phases are suspended at end of lever or tie rod at a particular temperature and by analogy of mechanical lever principle percentages of two phases are calculated.



Consider alloy at point C with certain wt. of solid and certain wt. of liquid at a particular temperature T. Then a tie line ACB or lever ACB is drawn at constant temp line. This lever intersects solidus line at point A and liquidus line at point B. Now Wt of solid is assumed to be attached at point A and wt. of liquid is assumed to be attached at point B.

Now $(\text{Wt of SOLID} + \text{Wt of Liquid}) = 100\%$ -----1. ----- **02 Marks**

In equilibrium condition lever is balanced condition taking moments about fulcrum point C we have

$$\text{Wt of SOLID} \times \text{AC} = \text{Wt of Liquid} \times \text{BC}$$

$$\text{Wt of SOLID} = (\text{BC} / \text{AC}) \times \text{Wt of Liquid}$$

Putting in equation 1 we get

$$(\text{BC} / \text{AC}) \times \text{Wt of Liquid} + \text{Wt. of liquid} = 100\%$$

$$(\text{BC}/\text{AC} + 1) \times \text{Wt of liquid} = 100\%$$

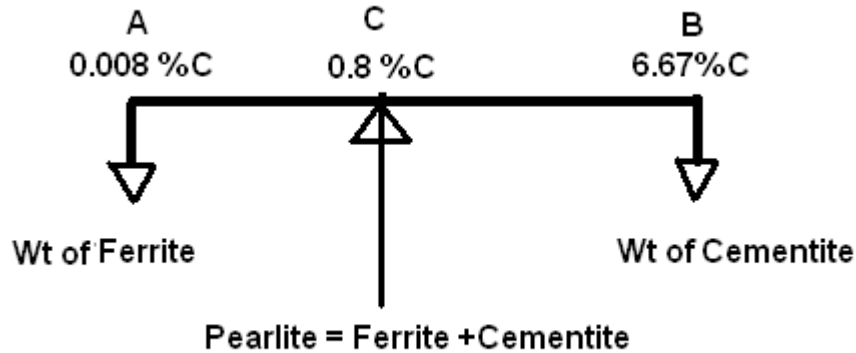
$$(\text{BC} + \text{AC}) / \text{AC} \times \text{Wt of liquid} = 100\% \quad \text{But } (\text{BC} + \text{AC}) = \text{AB}$$

$$\text{Wt of liquid} = (\text{AC}/\text{AB}) \times 100 \%$$

Similarly we get $\text{Wt of Solid} = (\text{BC}/\text{AB}) \times 100 \%$ ----- **02 Marks**

OR EXAMPLE OF FORMATION OF PEARLITE WHICH IS A MIXTURE OF FERRITE AND CEMENTITE CAN BE CONSIDERED IN EUTECTOID REACTION AS UNDER BY SAME ANALOGY.

In eutectoid reaction the fulcrum is drawn at 723°C as under



Applying Lever Rule $\text{Wt of Ferrite} = (BC/AB) \times 100 \%$

$$\text{Wt of Ferrite} = \left(\frac{6.67 - 0.8}{6.67 - 0.008} \right) \times 100 \%$$

$$\text{Wt of Ferrite} = (5.67/6.662) \times 100\%$$

$$\text{Wt of Ferrite} = \underline{88.11 \%} \quad \text{----- 02 marks}$$

Similarly

$$\text{Wt of Cementite} = (AC/AB) \times 100 \%$$

$$\text{Wt of Cementite} = \left(\frac{0.8 - 0.008}{6.67 - 0.008} \right) \times 100 \%$$

$$\text{Wt of Cementite} = (0.792 / 6.662) \times 100 \%$$

$$\text{Wt of Cementite} = 11.89 \% \quad \text{----- 02 Marks}$$

Suitable treatment given by student should be considered

D. Differentiate between normalizing and annealing. [4 MARKS , ANY FOUR POINTS 1 MARK EACH]

Normalizing -

- Heating range
- *Ac₃ + 50 for hypo eutectoid steels.
- *Ac₁ + 50 for eutectoid steel.
- *Ac_m + 50 for hyper eutectoid steels.
- Slow rate of cooling in the "air".
- austenite in the steel is transformed into the " fine pearlite structure"
- Resultant steel is soft and ductile.

Annealing -

- Heating range
- *Ac₃ + 50 for hypo eutectoid steels.
- *Ac₁ + 50 for eutectoid steel.
- *Ac₁ + 50 for hyper eutectoid steels
- Cooling the steel slowly to room temperature by switching off the furnace.
- Austenite is transformed into "coarse pearlite.
- resultant steel is hard and tough



E. Compare flame hardening and induction hardening. [4 MARKS , ANY FOUR POINTS 1 MARK EACH]

FLAME HARDENING

- Surface of steel is heated rapidly by oxyacetylene flame, then quenching.
- Success depends on skill of operator.

OPERATING VARIABLES ARE

1. distance between flame & work piece.
 2. gas pressure,
 3. flame or work travel rate,
 4. type, volume and application of quench.
- round shaped parts are suitable for flame hardening.

INDUCTION HARDENING

- Steel is heated by high freq. electric induction current and cooled rapidly.
- Success is related to selection and design of proper work coil.

OPERATING VARIABLES ARE

1. induced voltage
 2. flow of current
 3. resistance offered by work
 4. shape and design of coil & rate of heating.
- irregular shaped parts are not suitable for induction hardening. i.e. different coils are needed for different shaped parts.

F. State the effects of alloying elements on tool steel. [4 MARKS ,ANY 4 EFFECTS, 1 MARK EACH]

Carbon- it produces carbides and hardenable matrix, reduces toughness.

Chromium- it reduces tendency of scaling, improves hardenability, resistance to softening at elevated temperature.

Vanadium- it increases hardenability, abrasion resistance

Molybdenum- it increases hardenability, improves resistance to softening at elevated temperature.

Tungsten – it provides hot hardness, improves resistance to softening at elevated temperature.

Cobalt- decreases hardenability, makes cutting tool more wear resistant.

Q3.a) What is allotropy? State the allotropic changes of pure iron?

Ans : **Allotropy** is the property of the metal by virtue of which the same metal shows different crystal structure in different temperature range **1M**

Allotropic changes of pure iron:

The iron from 0 °c To 910⁰c Show B.C.C unit cell in space lattice Between 910⁰ To 1400⁰c the unit cell of iron become F.C.C Again between 1400⁰c -1539⁰c(up to melting point of pure iron) the unit cell become B.C.C

Iron is molten above 1539⁰c. It solidifies in the B.C.C δ form. On further cooling at 1400⁰c, a phase change occurs and the atoms rearrange themselves in to the (gamma) form which is F.C.C and non magnetic on still further cooling at 910⁰, another phase change occur from F.C.C non magnetic iron to B.C.C non magnetic α (alpha) iron. Finally at 768⁰c, the α -iron (B.C.C) becomes magnetic without a change in lattice structure.

Suitable description -----3M



b) Write a short note on martensite.

- Martensite is an interstitial supersaturated solid solution of carbon in iron having a body centered tetragonal lattice
- martensite is normally a product of quenching
- Martensite is the result of a shear type transformation with virtually no diffusion.
- Martensite is characterized by an acicular or needle like pattern.
- It has non cubic structure and since carbon is still present in the lattice, slip does not occur readily and therefore martensite is very hard, strong & brittle.
- The carbon content of martensite may be the same as of the original austenite.
- Very rapid cooling rate is essential to transform austenite into martensite. The cooling rate must exceed a critical value depending on composition.
- The austenite- martensite transformation starts at temperature M_s and continues as the temperature decreases to M_f , at which transformation reaction ceases. M_s & M_f temperatures are influenced by the carbon content in steel and both decrease with increasing carbon content.

Suitable description -----4M

c) Describe martempering process:

In martempering, steel is

- Heated to above the critical range to make it all austenite is then
 - Quenched into a salt bath maintained at a temperature above the M_s and is held at this temperature long enough until the temperature is uniform across the section of the work piece (from surface to core) without transformation of the austenite and
 - Subsequently cooling the work piece in air through the martensite range.
- The result is the formation of martensite with a minimum of stresses, distortion and cracking.
- The steel thus obtained may be further tempered in order to increase ductility
 - Large section cannot be heat treated by martempering because the time required to obtain temperature uniformity exceeds the start of transformation of austenite into Bainite.

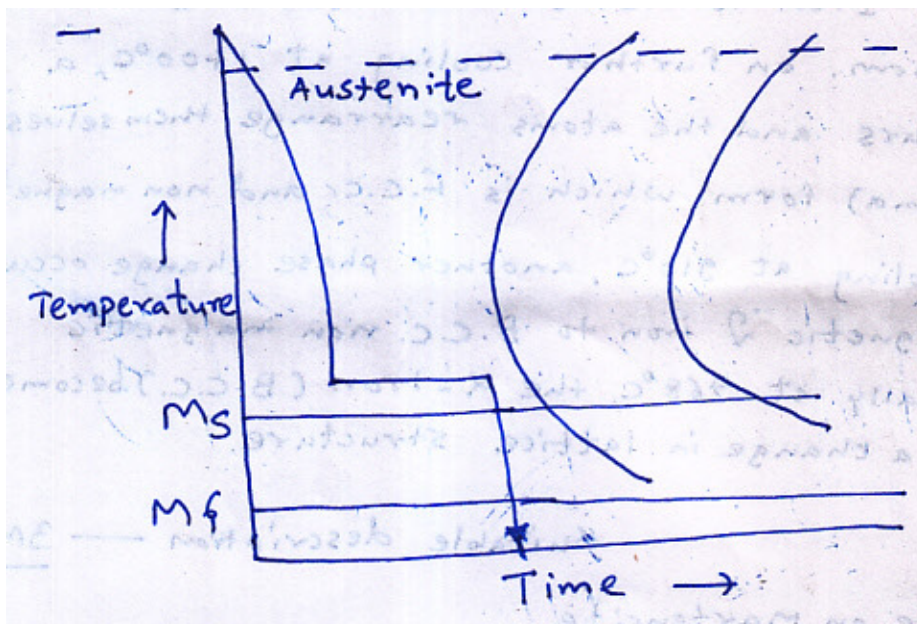




Diagram preferred but not essential With suitable description---4M

d) What is case hardening? What are its advantages?

In many industrial applications such as camshafts, crankshafts, gears etc. a hard and wear resistant surface called the case and relatively soft tough and shock resistant inside called the core is required. Such a requirement is difficult to achieve by using a steel of uniform composition. Low carbon steel containing about 0.1% carbon will be tough but low in hardness while a high carbon steel of 0.9% or more carbon will possess adequate hardness but not the toughness. Both requirements can be achieved either by changing the surface composition e.g. in low carbon steel by adding carbon, nitrogen or both to the surface or by selective hardening of the surface without changing the surface composition i.e. in medium carbon steel. These treatments are known as case hardening.

Suitable similar description----2M

Advantages:

- Improve corrosion resistance
- Improve heat and wear resistance
- Good fatigue resistance
- Very high surface hardness may be obtained
- To increase useful life of a part

Any Four point each carry 1/2M -2M

e) Classify mild steel according to % of carbon and give application of each type?

Mild steels may be classified as follows

- i) Dead mild steel- Carbon 0.05 to 0.15%
- ii) Mild steel containing 0.15 to 0.20% carbon
- iii) Mild steel containing 0.20 to 0.30% carbon

Similar suitable classification—2M

Application of mild steel types.

- i) Dead mild steel- used for making steel wire, sheets rivets, screws, pipes, nail & chain
- ii) Mild steel containing 0.15 to 0.20%- used for making camshafts strips for fan blades, forging etc.
- iii) Mild steel containing 0.20 to 0.30 – used for making for valves, gears, crankshafts, connecting rods, axles, fish plats, small forging etc.

Similar suitable applications ----2M

f) Classify various types of stainless steel and give one example of each

Stainless steel: are the alloy steels containing Cr, Ni and Mn as major alloying element and have very high corrosion resistance

Classification: All stainless steels can be grouped into following types depending on microstructure at room temperature

1) Ferritic Stainless steels:- Examples:- 1) AISI 405 – C 0.08% Si – 1% Mn-1% Cr-13-14%

2) AISI 442- C – 0.2% Si-1% Mn -1% Cr-23-27%

2) Austenetic stainless steel:- Examples:- i) AISI 201 – C-0.15% Si – 1% Ni-3.5% Mn-5-7% Cr-16-18%

2) AISI 304- C – 0.08% Si-1% Ni-8% Mn-2% Cr-18% PH

3) Martensitic stainless steel:- Example:- i) AISI 201- C-0.15% si-1% Ni-3.5% Mn-5-7% Cr-16-18%

ii) AISI 304- C-0.08% Si-1% Ni-8% Mn-2% Cr-18%

4) PH stainless steel Ex. 17-4 PH, 17-7 PH, AM-350

4 Marks



Q4 a) What is subcritical annealing? What are its purposes?

In this process, the cold worked steel is heated below the lower critical temperature usually 500°C to 700°C , holding at this temperature for a prolonged period followed by slow cooling i.e. air cooling. The holding time is usually 2 to 4 hours. It is applied to low carbon steel, cold rolled steel used in wire drawing and deep drawing operations. Subcritical annealing associates with it only partial recrystallization of the distorted ferrite and does not involve any phase change and the constituents' ferrite and cementite remain present in the structure throughout the process. It is generally carried out in either batch type or continuous furnace usually with an inert atmosphere of burnt coal gas.

Similar suitable description—3M

Purpose:- It is applied to

- remove the effects of cold work to soften and permit further cold work as in sheets & wire industries.
- relieve internal stresses
- refine and modify the structure
-

---1M

b) What is induction hardening? What are its features and applications?

Induction hardening:-It involves heating thin surface layer of hardenable steel and cast iron components by means of a high frequency induced current to a temperature within or above the transformation range followed immediately by quenching.

---1M

Features:-Inductor coil consisting of single or several turns of water cooled copper tube is used to heat the surface of the component within a short period of 2-5 minutes. Heat generated in the metal by induction is mostly confined to the outer surface of the component to be induction hardened- a phenomenon known as skin effect.

The depth of hardness is inversely proportional to square root of the frequency of current. At 50 Hz, the effective current flows through a surface layer of about 7.5mm deep, while at 10,000 Hz the surface layer is reduced to 0.5mm deep. High frequency currents are generated using motor generators, spark oscillators, vacuum-tube oscillators. The component part to be induction hardened is placed in the so called inductor or inductor coil.

Similar suitable description---2M

Applications:-Typical parts hardened by this method are

--Piston rods --Crankshaft --Spur gear ---Camshaft --Cams ---Automobile parts

Any two applications 1/2M for each---1M

c) Define pearlite and cementite.

Pearlite:- Pearlite is an eutectoid mixture of ferrite and cementite having pearly appearance under the microscope. It consists of alternate layers of ferrite and cementite. Pearlite is formed when austenite of 0.8% carbon decomposes at constant temperature of 723°C .

Suitable description—2M

Cementite:-This is an intermetallic compound of iron and carbon with a fixed carbon contain of 6.67% by weight. It is typical hard & brittle interstitial compound of low tensile strength but high compressive strength. Cementite is the hardest structure that appears on the iron-carbon diagram. Its crystal structure is orthorhombic.

Suitable description—2M



d) Write down the characteristics and applications of nodular cast iron.

Characteristics:-

- In nodular cast iron graphite appears as rounded particles or nodules.
- It possesses excellent castability, tensile strength and wear resistance
- possesses good ductility toughness and machinability
- Good damping capacity
- Soft grades of nodular cast iron can be turned at very high feeds & speeds.

Any Four points 1/2M for each---2M

Applications:-

- Paper industries machinery
- Internal combustion engines
- Valves and fittings
- steel mill roll
- Pipes
- Pumps and compressors
- Construction machinery
- Power transmission equipments

Any Four applications 1/2M for each---2M

e) List the advantages and limitations of powder metallurgy

Advantages:-

- Cleaner and quieter operation & longer life of the components
- High production rates
- Much uniform structure & defect free components
- No material is wasted as scrap
- Porous parts can be produced
- Highly skilled labour not required
- The use of diamond possible because of this complex shapes can be produced
- Good dimensional accuracy and surface finish is obtained

Any Four advantages 1/2M for each---2M

Limitations

- High tool & die cost associated with process
- Extreme care is required in handling powders to prevent fire or explosions
- Not economical for small production.
- Parts produced by this process in most cases do not have as good physical properties as cast parts
- Complicated shapes such as produced by casting cannot be made by powder metallurgy
- Size of the products is limited because of large presses required for compacting
- It may be difficult sometimes to obtain particular alloy powders

Any Four Limitations 1/2M for each---2M

f) What is carburizing? What are its advantages?

--Carburizing is a method of introducing carbon into solid iron-base alloys such as low carbon steels in order to produce a hard case. Carburizing increases the carbon content of the steel surface by a process of absorption and diffusion. Low carbon steel (about 0.20% carbon) is heated at 870⁰c to 925⁰c in contact with gaseous, solid or liquid



carbon containing substances for several hours. The high carbon steel surface thus obtained is hardened by quenching.

Similar suitable description---2M

Advantages

- Rapid heat transfer
- Low distortion
- Negligible surface oxidation & decarburization
- Rapid absorption of carbon
- Uniform case depth

Any Four advantages 1/2M for each---2M

Q.No.5 a. 1. Applications of Brasses: Brass is an alloy of Copper and Zinc. Brasses contain maximum up to 50% of zinc in it. Typical Applications are ,Cartridge and shell cases, radiator fins, condenser tubes, utensils shafts, propeller shafts, Brazing compound, springs, shafts, Nuts, Bolts, Architectural Work, Piston rods, pump impellers, boiler fittings, Valves, Bearing glands, Casting guns

(Any Four Applications) ----- 02 Marks

2. Applications of Bronzes: Bronzes are the alloys of copper containing any elements other than zinc. Zinc may be present in small amount. Typical Applications includes, Jewelry, cigarette cases, heat exchangers, castings, bearings, coins, gun barrels, Pump parts, Propellers, Springs, Statues etc.

(Any Four Applications) ----- 02 Marks

Q.No.5 b. Properties of ABS

Acrylonitrile Butadiene Styrene (ABS) is a type of Thermoplastic type of plastic. This is made up of chain molecules. ABS can be moulded and remoulded in any shape. This plastic is comparatively soft and less strong and chemically less inert. The heat resistance is low and cannot be used at higher temperatures. It has Good impact resistance, Rigidity, strength and toughness and moderate heat resistance.

----- 02 Marks

Applications of ABS

- *Toys
- *Refrigerator Lining material
- *Lawn and Garden equipments
- *Highway Safety devices
- *Automobile Parts
- *Hoses
- *Moulded parts

(Any Four Applications) ----- 02 Marks

Q.No.5 c. What is a Composite Materials? Give its one example.

Composite materials are the materials produced from two dissimilar materials. The composite material is better than the parent materials in view of properties. It is the combination of two or more materials with significantly better physical or chemical properties which they cannot achieve alone. The composite material may be preferred for many reasons: common examples include materials which are stronger, lighter good impact and corrosion resistant or less expensive when compared to traditional materials.

----- 02 Marks

(Any One Example from below or suitable)

----- 02 Marks

1. **Reinforced concrete:** Reinforced concrete is widely used in construction. Concrete is extremely weak in tension but very much stronger in compression. It has good bonding properties. It contains steel rods wires reinforced in matrix of cement, stones and water. Steel rods are stronger in tension. So RCC gives good strength in compression and tension as well. It is used in construction of Beams, Coloums and Slabs of building.



2. **Glass Fibre reinforced Plastic:** This is the plastic reinforced with fine glass fibers. It has excellent strength and formability. Glass reinforced fibre is also called as **Fiberglass** (or **fibreglass**) is a type of fiber reinforced plastic where the reinforcement fiber is specifically glass fiber. The glass fiber may be randomly arranged but is commonly woven into a mat. The plastic matrix may be a thermosetting plastic- most often epoxy, polyester resin- or vinylester, or a thermoplastic. The glass fibers are made of various types of glass depending upon the fiberglass use. These glasses all contain silica or silicate, with varying amounts of oxides of calcium, magnesium, and sometimes boron. To be used in fiberglass, glass fibers are made with very low levels of defects. Applications of fiberglass includes aircraft, boats, automobiles, bath tubs and enclosures, hot tubs, septic tanks, water tanks, roofing, pipes, cladding, casts, surfboards, and external door skins.
3. **Laminates:** Layered composites are called as laminates. Examples are as under,
- Plywood:** It is laminated composite of thin layer of wood in which successive layers have different orientation of grain or fibers. **Plywood** is a sheet material manufactured from thin layers or "plies" of wood veneer that are glued together with adjacent layers having their wood grain rotated up to 90 degrees to one another. It is an engineered wood from the family of manufactured boards which includes medium-density fiberboard (MDF) and particle board (chipboard).
 - Copper stainless steel laminates
 - Laminated Plastic sheets
 - TUFNOL: Layers of woven textiles bonded with thermosetting resin, providing high tensile strength and rigidity.

Q.No.5 d. 1. Powder Metallurgy(Definition): Powder metallurgy is the branch of metallurgy which deals with the production of metal and nonmetal powders and subsequent manufacturing of components or parts using these powders. ----- **01 Mark**

2. Concept of Powder Metallurgy: Powder metallurgy involves production of components using metal and nonmetal powder mixtures. Process involves following steps,

- Production of Metal/Non metal powders and mixtures.
- Blending and mixing of powders.
- Compacting powder in dies to semi-finished compacted shape of component.
- Sintering or heating the compacted component in furnace.

Components made from powder metallurgy process has better strength, Machinability, Bearing properties, accuracy in dimensions. ----- **03 Marks**

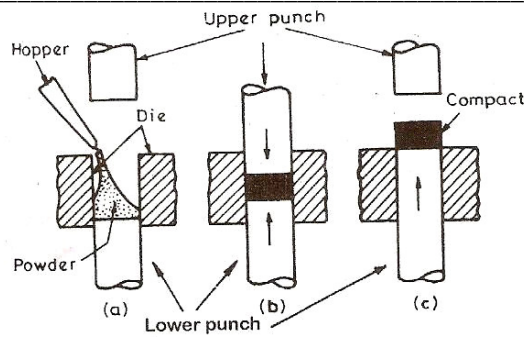
Q.No.5 e. Compacting Process In Powder Metallurgy:

Powder compaction is the process of compacting metal powder in a die through the application of high pressures. Typically the tools are held in the vertical orientation with the punch tool forming the bottom of the cavity. The powder is then compacted into a shape and then ejected from the die cavity. In a number of these applications the parts may require very little additional work for their intended use; making for very cost efficient manufacturing.

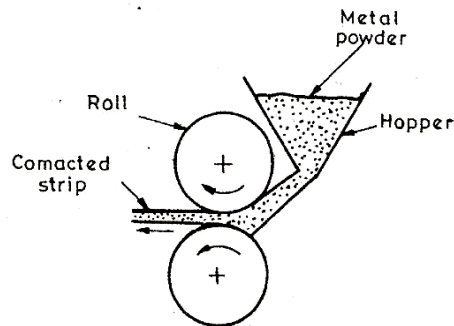
01 Mark

Powder compaction can be done by following methods as under

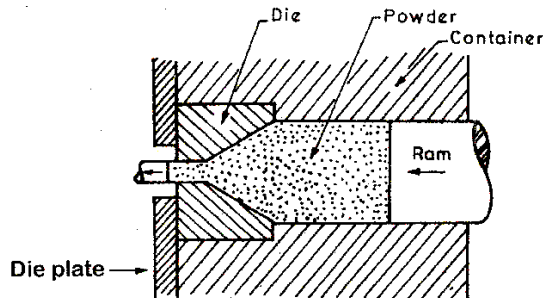
- Die pressing:** Blended and mixed powder is placed in die through hopper and is then compressed to a high pressure of 60-70 Kgf/cm² as shown in figure.



- b. **Roll Pressing:** The strip of powder is guided between two rolls. Rolls apply pressure to compact the powder in the form of a continuous strip as shown below.



- c. **Extrusion:** Here the powder is passed through the extrusion die. The high pressure is applied by the ram as shown, as a result the compacted shape comes out of die.



03 Marks

Q.No.5 f. Case Hardening : In many industrial applications such as camshafts, crankshafts, gears etc. a hard and wear resistant surface called the case and relatively soft tough and shock resistant inside called the core is required. Such a requirement is difficult to achieve by using a steel of uniform composition. Low carbon steel containing about 0.1% carbon will be tough but low in hardness while a high carbon steel of 0.9% or more carbon will possess adequate hardness but not the toughness. Both requirements can be achieved either by changing the surface composition e.g. in low carbon steel by adding carbon, nitrogen or both to the surface or by selective hardening of the surface without changing the surface composition i.e. in medium carbon steel. These treatments are known as case hardening.

----- 02 Marks

Types of Case Hardening: Following are main types of case hardening process.

1. By changing surface composition- Solid Carburizing, Gas Carburizing, Liquid Carburizing, Nitriding, Cyaniding
2. Without changing surface composition- Flame hardening, Induction Hardening

----- 02 Marks



Q.No.6 a. Purposes Of Normalising:

To refine grain structure of steel

To eliminate coarse grain structure in steel

To modify dendritic structure.

To reduce segregation.

To relieve internal stresses

To improve/obtain Mechanical properties.

To produce harder and stronger steel than obtained by Annealing.

(Any Four Purposes) ----- 02 Marks

Normalising Process: In general the normalizing process is carried out in following steps,

1. **Heating the steel part** to normalizing temperature zone in the furnace. For Plain Carbon Steels this range is $A_{C3} + 50^{\circ}C$ for Hypo eutectoid steels, $A_{C1} + 50^{\circ}C$ for Eutectoid steel and $A_{Cm} + 50^{\circ}C$ for Hyper eutectoid steels. For alloy steels range depends upon type of alloy steel.
2. **Holding the steel part** at the Normalizing temperature for stipulated period of time. The holding time depends upon shape and size of steel part and type of steel.
3. **Cooling the steel part in the still air or circulating air** to room temperature to form fine pearlite in microstructure of steel part. ----- **02 Marks**

Q.No.6 b. Flow chart for production of Malleable Cast Iron

PRODUCTION OF WHITE CAST IRON CASTINGS



HEATING WHITE CAST IRON CASTING IN FURNACE TO TEMPERATURE OF $1050^{\circ}C$ FOR PERIOD OF 72 TO 96 HOURS



SLOW DECOMPOSITION OF PRILIMINARY CEMENTITE TO AUSTENITE AND TEMPER CARBON OR IRREGULAR SHAPED GRAPHITE PARTICLES (PRIMARY GRAPHITIZATION PROCESS) OCCURS IN WHITE CAST IRON CASTINGS



DIRECT SLOW COOLING FROM $1050^{\circ}C$ TO ROOM TEMPERATURE TO FOR PEARLITIC MALLEABLE CAST IRON

OR

SLOW COOLING FROM $1050^{\circ}C$ TO $760^{\circ}C$ AND FROM $760^{\circ}C$ FURTHER SLOW COOLING TO ROOM TEMPERATURE TO FORM FERRITIC MALLEABLE CAST IRON. HERE IN SECON STEP OF SLOW COOLING SLOW DECOMPOSITION OF SECONDARY CEMENTITE TO AUSTENITE AND TEMPER CARBON OR IRREGULAR SHAPED GRAPHITE PARTICLES (SECONDARY GRAPHITIZATION PROCESS) OCCURS CAST IRON CASTINGS TO FORM FERRITIC MALLEABLE CAST IRON

Suitable Flow chart

----- **04 Marks**



Q.No.6 c. Effects of Phosphorous on properties of steel

- Nuisance element in steel. It makes the steel “Cold Short” i.e. excess amount of phosphorous leads to cracking of steel during cold working process.
- Makes the steel brittle.
- Decreases the soft magnetic properties in steel and undesirable in magnetic steels.
- Increases strength , hardness and resistance to corrosion.
- Improves machinability when added to 0.12 % level.
- Form a banded undesirable structure in steel.

----- 02 Marks

Effects of Silicon on properties of steel

- Dissolves in ferrite, increases strength and hardness without reducing ductility.
- Strong De-oxidizer, removes oxygen from melt.
- Improves permeability and reduces iron core loss in magnetic steels.
- Improves toughness and used in steels for making springs, chisels, punches.
- Strong graphitizer, decomposes cementite to graphite and ferrite.

----- 02 Marks

Q.No.6 d. Applications of Polyesters

- Helmets
- Fibre glass boats
- Chairs
- Fan Blades
- Mat
- Insulation for wires and cables.

----- 02 Marks

Applications of Epoxy

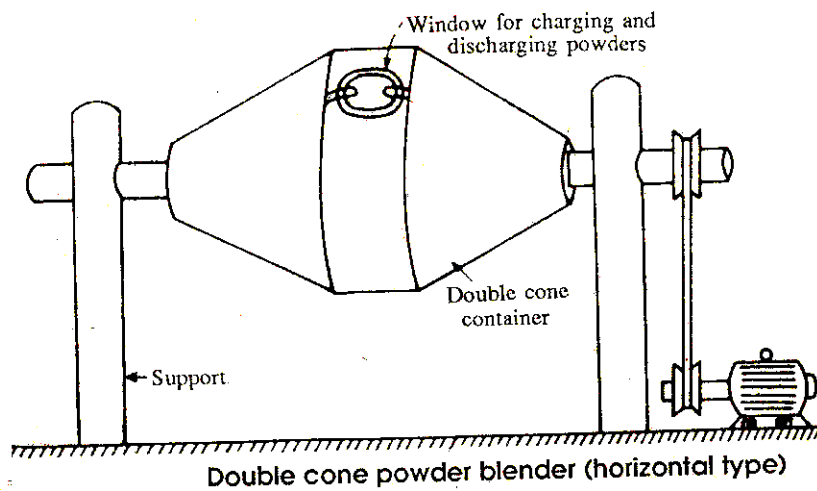
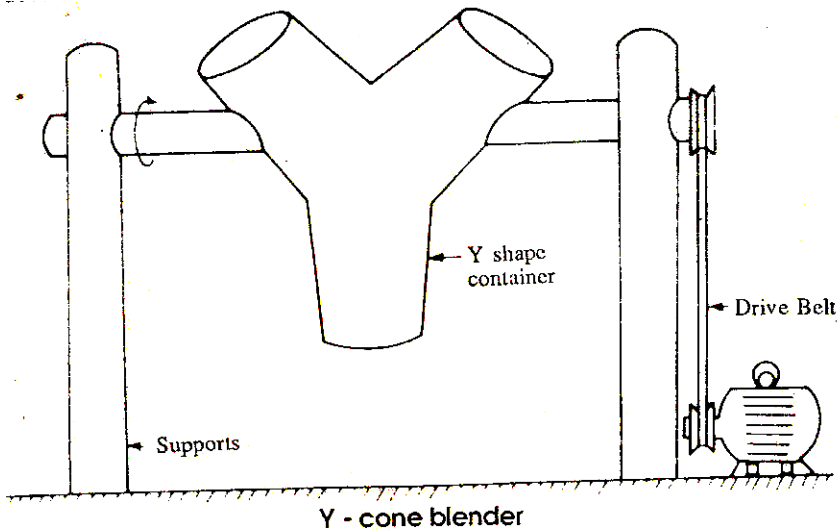
- Adhesives
- Electrical Mouldings
- Laminates
- High voltage insulating materials
- Protective Coatings.

----- 02 Marks

Q.No.6 e. Blending Process in Powder Metallurgy

It is the operation of thorough mixing of different powders of the same compositions or different compositions. The main aim of blending or mixing is to obtain a homogeneous mixture of powder which helps in improving the compacting and sintering process. Additives such as binders or lubricants are added in order to control the strength and porosities.

Various types of blenders and mixers are used for the blending and mixing process. Ball mills or rod mills are used for mixing hard metals. Y mixers or double cone mixers are used for mixing the soft metals as shown below.



Mixing can be done by **Wet method** or by **Dry method**. Generally wet mixing is used to produce more fine mixtures of powder particles.

Main aims of blending process are

- To mix powders thoroughly and with same or different compositions.
- Make a homogeneous mixture of powders.
- Keep the uniformity of mixture.
- Adopt wet mixing to produce fine mixtures.

----- 04 Marks

Q.No.6 f. 1. **Creep** : Creep is the time dependent permanent deformation of the metal or material under a tensile load at an elevated temperature. Whenever a material is subjected to a tensile constant load at elevated temperature and exposed to a long time, then there is a time dependent deformation or elongation of material occurs. This is called as creep. Creep occurs in three stages 1.Primary Creep 2. Secondary Creep and 3. Tertiary creep. The material fails after tertiary creep.

----- 02 Marks

2. **Toughness** : Toughness is the ability of the material to absorb energy during plastic deformation up to fracture. This absorbed energy is the sum of elastic energy and plastic energy. Toughness is represented by total area under stress – strain curve up to fracture.

----- 02 Marks