SUMMER– 14 EXAMINATION

Subject Code: **17303** **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.

Q.1

a) **Hardness** is defined as the ability of a material to resist scratching, abrasion, cutting or penetration. Hardness is also measured by resistance to wear of a material. **(01 Marks)**

Toughness is defined as the amount of energy a material can absorb without breaking or fracture. **(01 Marks)**

b) 40 Cr 4 Mo_2 means alloy Steel having average 0.4% carbon , 4% Chromium and 0.2 % Molybdenum. **(02 Marks)**

c) The percentage of carbon in Low Carbon Steel (Mild Steel) is 0.05% to 0.30 %.

(02 Marks)

d) **Purpose of Normalising** **(02 Marks)**

1. To increase strength and hardness.
2. To obtain more refined grains than the annealing.
3. To remove the internal stresses induced by heat treating, welding, casting etc.
4. To improve machinability of low carbon steel.

e) **Any four objectives of Heat Treatment** **(Any four - 02 Marks)**

1. To refine grain structure.
2. To improve machinability.
3. To relieve internal stresses.

4.To increase strength and wear resistance.

5. To increase corrosion resistance.

6. To increase Hardness and toughness of metal surface.

7. Formation of stable phase.

8. To improve magnetic and electrical properties.

f) The primary requirement of a tool steel is that it shall have considerable hardness and wear resistance with high mechanical strength and toughness.

Hence tool steels which work at high speed are generally mixed with one or more of those elements which form very hard carbides.

Ex. Chromium, Tungsten, Molybdenum or Vanadium. **(02 Marks)**

g) **Application of gray cast iron** **(02 Marks)**

Engine cylinder blocks, flywheels, gears, machines-tool bases, cylinder bores, Piston rings, Slideways on machine tools.

h) The **bronze** is an alloy of copper and tin and minor percentage of other elements.

Classification of bronze

1.Phosphor bronze

2.Gun metal

3.Bell metal

4.Aluminum Bronze **(Def. 01 Mark Classification-01 Mark)**

i) **Application of Gun Metal** **(02 Marks)**

1. It is extensively used for casting boiler fittings ,bushes, bearings, glands,gun barrels ,Valve bodies,marine casting.

2. In general it is used for bolts, nuts, naval constructions.

j) **Applications of Polyster** **(02 Marks)**

Paints, Binders for glass fibers, Safety helmets, Fiber glass boats, Joining and repair works,Cladding panels, Automobile body components, Fans, Chairs.

k)**Classification of polymer materials.** **(02 Marks)**

1. According to origin

    1. Natural Polymer 2. Synthetic or artificial Polymer

2. According thermal behaviour.

1. Thermoplastic polymer 2. Thermosetting plastic polymer

3. According to structure.

1. Link polymer. 2. Branched polymer 3. Crossed link polymer

4. According to form

1. Plastic 2. Elastomers 3. Fiber and resins

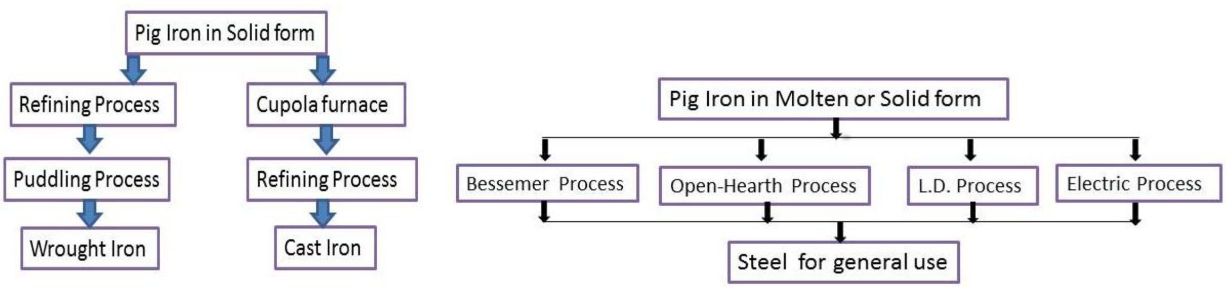
l) **Powder making process. (½ mark each)**

1. Mechanical : Machining, crushing, milling, shotting , graining etc.
2. Atomization.
3. Chemical reaction process
4. Electrolytic process.

Q.2

a) **Flow diagram for production of iron and Steel**

(Dig. For Iron-02 Marks, For Steel-02 Marks)



b) **(Dig. For Pure Metal-01 Marks, For alloy-01Marks , Explanation-02 Mark)**

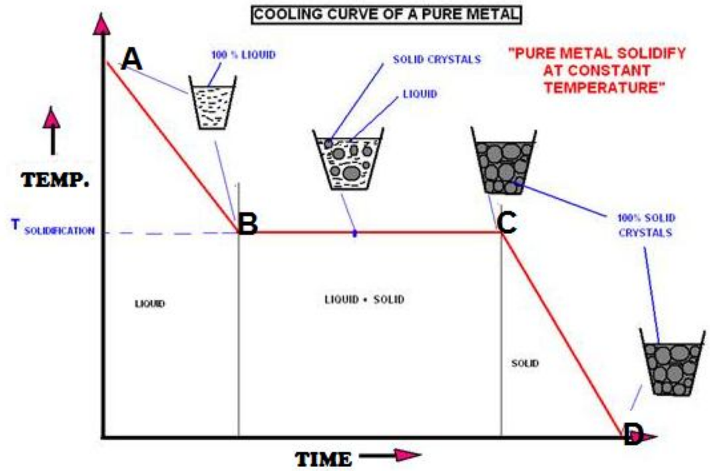


Fig.1

Pure metals melt and solidify at the single temperature which may be termed as the freezing point or solidification point as shown in Fig.1.

The time versus temperature plot under normal conditions indicates that the liquid metal cools from A to B. This is the liquid shrinkage phase. Here the heat is liberated in the form of superheat.

Pure metal solidifies at constant temperature as shown in **Fig.1**.i.e. Solidification starts at point B and ends at point C. From C to D the solid metal cools and tends to reach room temperature.

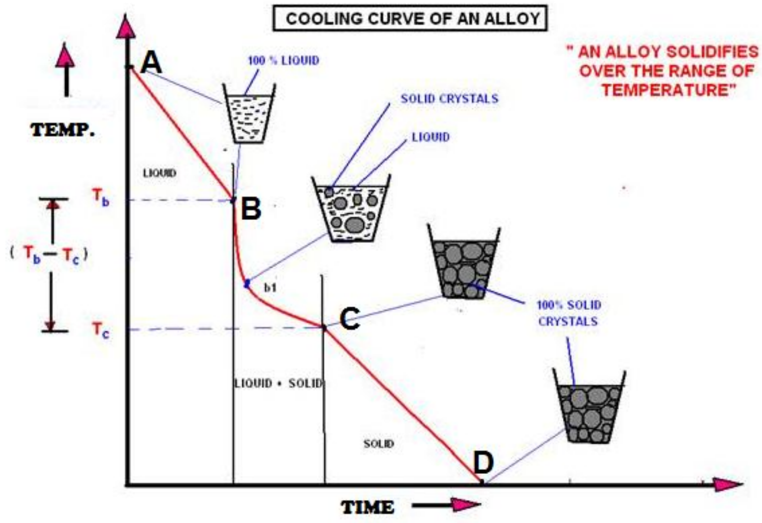


Fig.2

Alloys solidifies over the range of temperature**(T_B-T_C)**as shown in **Fig.2** i.e. Solidification starts at point B and ends at point C.From C to D the solid metal cools and tends to reach room temperature.

c. Heat Treatment:(Def.-02 Mark, Needs any Four points -02 Mark)

Heat treatment is the controlled heating and cooling of metals to alter their physical and mechanical properties without changing the product shape. **Or.**

Heat treatment is a series of operations involving the heating and cooling of metal or alloy in the solid state ,for the purpose of obtaining certain desirable properties.

Needs of Heat Treatment.

1.To refine grain structure.

2.To improve machinability.

3.To relive internal stresses.

4.To increase strength and wear resistance.

5.To increase corrosion resistance.

6.To increase hardness and toughness of metal surfaces.

d) **Stainless steel** : The steel having high corrosion resistance and do not corrode on most of the usual environmental conditions are called as stainless steel.**Properties:-**

1. High ductility and formability.
2. Good weldibility.
3. Good machinability.
4. Good creep resistance.
5. Excellent surface finish and appearance.
6. High corrosion resistance.

Applications:-Kitchen sinks, food processing equipment's, chemical plants and equipments,Knife blades, surgical instruments, shafts,spindles,pins etc.

(Def.-01 Mark, Any two Properties-02 Mark, Any two Applications -01 Mark)

e) **Y-alloy** : Composition- 92.5% Al, 4%cu, 2% Ni, 1.5% Mg

Properties:-1. Its strength at 200^{o}C is better than aluminium.

2. It retains its high strength and hardness at high temperatures.
3. It can be easily cast and hot worked.
4. It is good conductor of heat.

Uses:

1. It is extensively used in I.C. Engine for piston cylinder head and crank case.
2. It is also used for die-casting, pump rods and in sparking chisels in place of steel.

(Composition with Properties – 02 Marks, Any four Uses-02 Marks)

f) **Applications (Any Two Application each – 02 x02 Marks, - 04 Marks)**

i) Ceramics :

1. Consumer Uses : Glassware windows, pottery, corning ware dinner ware etc.
2. Automotive : Catalytic converters, ceramic filters, air bag sensors, ceramic rotors, Spark plug etc.
3. Medical : Orthopedic joint replacement, dental restoration , bone implants etc.
4. Other industries: Bricks, cement, lab equipment's, chemical industries.

ii) Asbestos:

Fire proof textiles, Fire proof theatre curtain, Boiler insulation, Brake shoes, Pipe insulation, gaskets, Protective pads.

Q.3 a) Describe laminated and reinforced composites?

ANS:

Laminated composites:

Here the composite material consists of two or more layers of unlike components. Examples are laminated plywood, Alcad aluminium alloy, copper clad stainless steels and titanium clad steel. Thermostatic controls consisting of a bimetallic strip of copper and nickel used to control temperature in ovens and furnaces is also a composite material of this type. The properties of these composites and fibre reinforced composites are highly sensitive to direction of loading with respect to the direction of laminates or fibres**.(02 marks)**

Reinforced composites:

Here the fibre of high strength materials are introduced in to the soft and ductile matrix gets increased by high strength fibres.The resulting composite material will have high stiffness, high specific strength, elevated temperature strength and high fracture toughness. Fibres mainly bear the load and the matrix transfers and distributes the external loads to the fibres. Also, the matrix protects the fibres from external actions and imparts certain physic-chemical properties such as resistance to corrosion and oxidation, electrical and thermal conductivity, etc. **.**

(02 marks)

b) Describe spheroidise annealing in brief? (04 marks for appropriate answer)

This heat treatment is given to high carbon and air hardening alloy steels to soften them and to increase machinability. The microstructure, typical of this heat treatment shows globules of cementite or carbides in the matrix of ferrite. Any heat treatment that produces a structure of the above is called spheroidise annealing.

Following methods produces spheroidised structure:

i) Hardening and high temperature tempering

Due to tempering of hardened steels at 650-700°c for a long time, cementite globules are formed in the matrix of ferrite from martensite.

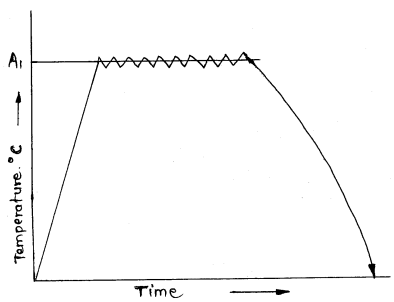
Martensite ⟶ cementite (in globular form) + ferrite

ii) Holding at just below A1

Due to holding for a long time at just below the lower critical temperature, cementite from pearlite globularizes. The process is very slow and requires more time for obtaining spheroidise structure. It can be accelerated by prior cold working of steel. However, this may not be possible in many cases where the steel is brittle e.g. alloy steels and high carbon steels cannot be worked much in the annealed or normalized condition without cracking.

iii) Thermal cycling around A1

Due to thermal cycling in a narrow temperature interval around A1, cementite or carbides try to dissolve and during cooling they try to form. This repeated action spheroidises the carbide particles. A typical heat treatment cycle of this type is shown in figure.



A typical heat treatment cycle to produce spheroidised structure.

c) What is cast iron? Give its classification?

Cast irons are basically the alloys of iron and carbon in which the carbon varies between 2.0 to 6.67 % i.e. more than the solubility limit of carbon in austenite and less than the carbon content of cementite. Commercial cast irons are complex in composition and contain carbon in the range of 2.3-3.75% with other element such as silicon, phosphorous, sulphur and manganese in substantial amount. Because of their poor ductility and malleability, they cannot be forged, rolled, drawn, or pressed into the desired shape but are formed by melting and casting with or without machining to the required final shape and size, and hence the name Cast Iron.**(02 marks)**

Classification of Cast Iron: . (02 marks)

i) On the basis of furnace used in their manufacture:

1. cupola cast iron
2. air furnace cast iron
3. electric furnace cast iron
4. duplex cast iron

ii) On the basis of composition and purity:

1. low carbon ,low silicon cast iron
2. high carbon, low sulphur cast iron
3. nickel alloy cast iron

iii) On the basis of microstructure and appearance of fraction:

1. white cast iron
2. malleable cast iron
3. gray cast iron
4. nodular cast iron
5. mottled cast iron
6. chilled cast iron
7. alloy cast iron

d) What are required properties of bearing materials? (any eight, ½ mark each)

The good bearing material should have the following properties:

1. The friction between the bearing and the rotating part should be as small as possible to reduce the power loss in transmission.
2. The affinity between the shaft and the bearing material should be minimum.
3. It should be hard and wear resistant for longer life. However it should not be harder than the shaft so as to avoid the damage to the shaft.
4. It should have sufficient load bearing ability.
5. It should have sufficient plasticity and deformability to take care of large deflections and misalignment of the shaft.
6. It should have high fatigue resistance.
7. It should have good resistance to galling and seizing.
8. It should have good thermal conductivity so that the frictional heat, if any produced is dissipated quickly.
9. It should not have very high or very low melting point.
10. It should have very high oil retaining capacity.

e) What is white metal? State its applications?

These are also called as "babbits". These are either lead based or tin based alloys. both the types contain antimony. The lead based Babbitt contains tin also. Other element present in some of the Babbitts are Cu, Cd, and As.

The microstructure of a Babbitt consists of hard cuboids of Sn-Sb in a soft matrix of eutectic. In addition to Sn-Sb cuboids, the microstructure may consist of hard needles of Cu Sn and hard star shaped crystals of Cu_3Sn, if the Babbitt contains copper. Tin based babbitts have better corrosion and wear resistance as compared to lead based babbitts but are costly. Lead is added to these babbitts to reduce their cost. However, lead decreases the load bearing ability of these bearings **.(02 marks)**

Applications: . **(02 marks)**

a) Used for diesel engine crank shafts bearings
b) Bearings of heavy duty vehicle.
c) High capacity Presses.
d) Cranes, hoists

f) Describe nitriding process? (04 marks for appropriate answer)

ANS:

Nitriding is accomplished by heating the steel in contact with a source of atomic nitrogen at a temperature of about 550°c. The atomic nitrogen diffuses in to the steel and combines with iron and certain alloying element present in the steel and forms respective nitrides. These nitrides increase the hardness and wear resistance of steels. Molecular nitrogen does not diffuse in to the steel and hence is completely ineffective as a nitriding medium. The atomic source of nitrogen can be a molten salt bath containing NaCN similar to that used in liquid carburizing without the addition of alkaline earth salts or dissociated ammonia and accordingly the process is called liquid nitriding or gas nitriding.

In liquid nitriding, nitriding occurs by formation and decomposition of cynate by the same reaction as given in liquid carburizing. Since the temperature of nitriding is less (550°c), carbon cannot diffuse in to the steel because of absence of austenite and hence only nitrogen diffuses in to the steel.

The gas nitriding is very much similar in operation to that of gas carburizing. The atomic nitrogen produced due to the dissociation of ammonia diffuses in to the steel. For good results control over dissociation rate of ammonia and its circulation is necessary. In the presence of alloying elements in solid solution respective nitrides are formed. These nitrides are hard and tough and therefore such a layer of nitrides does not crack or chip. At the usual temperature of nitriding, these alloy nitrides precipitate out in the form of very fine needles in the matrix of ferrite. Due to this, they remarkably increase the hardness without increase in brittleness.

.**Q.4**

a) Describe flame hardening with its principle and neat sketch?

(02 marks for sketch, 02 marks for porinciple)

ANS:

Flame hardening is a process of heating the surface layer of hardenable steel to above its upper critical temperature by means of oxyacetylene flames followed by water spray quenching or immersion quenching to transform austenite in to martensite. Flame hardening can be done in different ways such as by spot method, progressive method, spinning method, or combination of progressive and spinning method. In spot hardening, a spot or local area of the component is heated by one or more flames followed by quenching in water. In progressive method, heating and quenching devices are moved over the component surface at a controlled rate. Spinning method is used for parts having a rotational symmetry in which the flames are held against a rotating work piece and when heating is complete, the part is quenched by water spray or by complete immersion in water. In combination method, the work is rotated and the flames are traversed for heating followed by quenching in water or by water spray.

Depth of hardened layer depends on following parameters:

a) Distance between the gas flames and the component surface.
b) Gas pressures and ratios.
c) Rate of travel of flame-head or component.
d) Type, volume and application of quench.

By controlling above parameters, the depth of hardened layer can be varied from a very small to a maximum of about 5mm. Any type of haredenable steel or cast iron can be flame hardened. Flame hardened components are tempered at low temperature to relieve internal stresses. Flame hardening causes less distortion than conventional hardening and due to high heating rate, oxidation and decarburization are minimum.

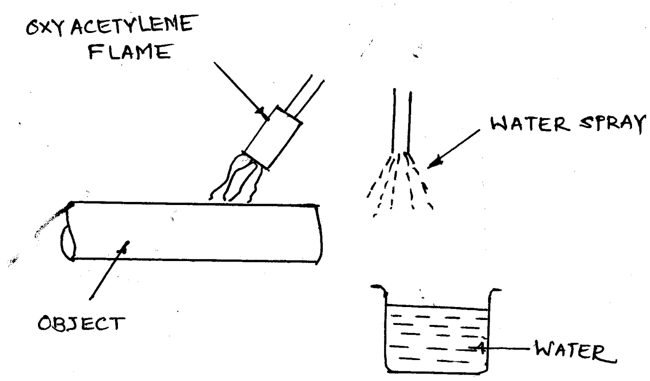


FIGURE: FLAME HARDENING

b) Define pig iron? State its types with their properties?

(02 marks for def. 02 marks for types & properties)

ANS:

Pig iron is the raw material obtained from chemical reduction of iron ore in the blast furnace. The process of reduction of iron ore to pig iron is known as smelting. the main raw materials required for pig iron are i) iron ore ii) coking coal iii) flux.

Iron ores are generally carbonates, hydrates or oxides of metal, the letter being the best.

The coke used in the blast furnace should be a very high class hard coke obtained from good quality coking coals containing as low phosphorus and sulphur as possible. It is produced by heating what is commonly called "dry distillation" of the coking coals in coke ovens made of silica bricks in the absence of air to avoid giving off valuable gases. A light, porous, sufficiently firm fuel which burns well is thus obtained.

Flux is a mineral substance that is charged in to a blast furnace to lower the melting point of the ore to promote the removal of ash, sulphur and residues of the burnt fuel. Flux combines with the ashes of the fuel and the ore to form fusible products which separate from the metal as slag. The most commonly used blast furnace flux is lime stone.

Types of pig iron:

Pig iron is often used to make cast iron which can be classified in to five generic types based on the form and shape of the carbon portion in its microstructure those types are

Gray pig iron: gray pig iron is name out of the flake shape graphite within its wider ferrite and pearlite microstructure giving its gray appearance and is intended for an economical casting production.

Nodular or ductile iron: it is also known as spheroidal graphite iron comes from after inserting a specific amount of magnesium or cerium, those elements reacts with sulphur and oxygen allowing the carbon to separate like spheroidal particles.

Malleable iron : These irons are having good malleable property than ordinary cast iron.

Compacted graphite iron: It is also known as vermicular graphite iron it differs from the gray iron because the graphite particles are shorter and thicker this results in stronger adhesion between graphite and iron.

White iron: it contains carbon in the form of cementite; this is obtained by the presence of relatively large quantity of manganese and very small amount of silicon and by rapid cooling.

c) What is meant by HSS? What are its characteristics?

(02 marks for def. 02 marks for characteristics)

ANS:

HSS means high speed steels.These steels maintain high hardness up to a temperature of about 550°c and hence can be used for cutting of metals at high speeds. They also have high wear resistance and cutting ability.

High speed steels are divided in to two types depending on the principle alloying element. The first group is called tungsten high speed steels which contain high amount of W with other element such as Cr, V and Co. They are designated by **T-series.**

The second group of high speed steel is called molybdenum steels. a part of tungsten from the group of W-high speed steel is substituted by molybdenum and hence these steels contain W, Cr, V and Co in addition to Mo. this substitution results in lowering the cost of steel. This type is designated by **M-series.**

Characteristics: W, Mo, Cr, and V are carbide formers and hence form respective carbides. These alloy carbides increase red hardness, wear resistance and cutting ability at high temperature. Vanadium also increases the resistance to grain coarsening .a super high speed steel contains about 5% V and shows a very high hardness. Cobalt permits cutting of hard abrasive materials and gives the ability to maintain hardness at high temperature.

These steels are used for drills, taps, reamers, milling cutters saws, lathe tools, punches, drawing dies and wood working tools.

d) Describe X-ray radiography with neat sketch?

(02 marks for sketch,02 marks for description)

ANS:

This is used for detecting defects in components manufactured by casting, welding, forging, etc. here the component to be examined is exposed to radiations of short wavelength such as X-rays of wavelength 0.2 to 5A° or γ-rays of still shorter wavelengths from a suitable source such as an X-ray tube or cobalt 60.these radiations penetrate through the component and while doing so, they are absorbed by the material. The penetrating ability of these radiations depends on their wavelength and the absorbing power of the material. When these rays pass through a material of non uniform structure containing defects such as cavities or cracks or regions of variable density ,the rays passing through a less dense region of the object are absorbed to a smaller extent than the rays passing through the adjacent sound material. The amount of radiation emerging from the opposite side of the material can be recorded and from the observed variations, defects can be detected. The recording is usually done by placing a film sensitive to radiations in a cassette at the end of the object. After development of the film, it shows a picture of light and dark areas, the letter representing the regions of the material of low density such as gamma graph when produced by gamma rays and both of them are called radiographs. The general principle involved in the production of radiograph by the use of X-rays or γ-rays is illustrated in the figure.

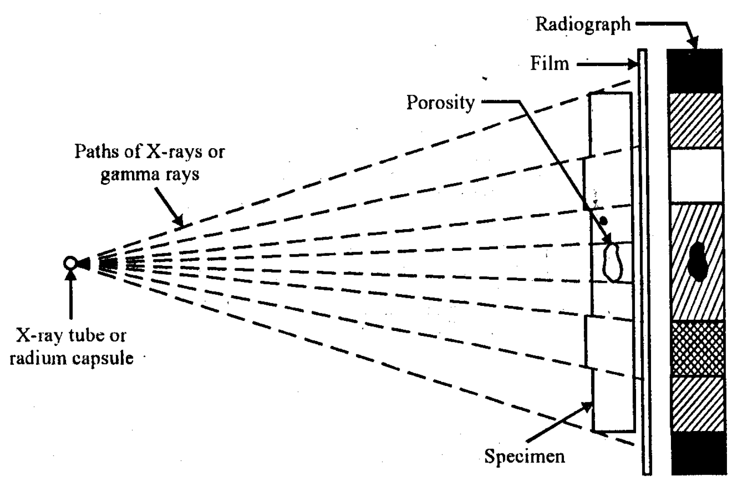


Figure: production of Radiograph

e) State the advantages and disadvantages of powder metallurgy?

Advantages(any four, 02 marks)

1. Metal plus metal components can be manufactured by powder metallurgy. there is almost no need of referring to their equilibrium or phase diagram
2. Components of desired composition can be manufactured.
3. Metal plus nonmetal components can be manufactured which are quite impossible to manufacture by the usual methods.
4. Controlled porosity can be obtained in the components.
5. It is possible to produce components with properties similar to the parent metals whereas, if the components are manufactured by melting, the alloy may have different properties from their parent metals.
6. Production of refractory metals like W, Mo, Ti, Th, etc is possible without melting.
7. Components from metals which are completely insoluble in the liquid state can be manufactured with uniform distribution of one metal in to the other.
8. Composite and dispersion hardened materials can be manufactured e.g. cermets and thoria dispersed tungsten filaments.
9. Powder metallurgy parts may be welded, brazed, machined, heat treated, plated or impregnated with lubricants or other materials.
10. Close control over the dimensions of the finished components can be easily obtained.

Disadvantages: (any four, 02 marks)

1. Most of the powder used in p/w is fine and fine powders of some of the metals like Mg, Al, Zr, Ti, etc are likely to explode and cause fire hazards when they come in contact with air and hence, they should be preserved carefully. Other metal powders are likely to get oxidize slowly in the air and hence, they must be stored properly to avoid their detoriation.
2. It is not suitable to manufacture small number of components because of high initial investment on tooling and equipment.
3. Large sized components cannot be manufactured because of the limited capacity of presses available for compaction.
4. Complex shaped parts cannot be manufactured with ease to powder metallurgy.
5. P/M parts have poor corrosion resistance because they are porous. Due to this porosity, large internal surface area gets exposed to corrosive environment.
6. Components with theoretical density cannot be manufactured.

7. Due to the presence of porosity, mechanical properties such as ductility, U.T.S. and toughness are poor as compared to components manufactured by conventional methods; the surface finish is also poor.

f) State the different properties of composite materials (any four, one mark each)

1. High specific strength of these materials and possibility of obtaining desired combination of properties by proper selection of the matrix and fibre and by variation of concentration and orientation of fibre.
2. Fibre reinforced composite are highly sensitive to direction of loading with respect to direction of laminated fibres.
3. These materials are having high mechanical strength as compared to other materials.
4. These materials are high resistance to heat.
5. We can combine different materials to obtain the desired properties.
6. These materials can be made artificially.
7. These are the materials with combination of two or mechanically unlike materials with distinct boundaries between them.
8. Fibre composite materials will have high stiffness , elevated temperature strength and high fracture toughness.
9. Resistance to corrosion and oxidation, electrical and thermal conductivity.

Q. 5 a)

1) State and describe steels which are used as tool steels.

Tool steels are classified and designated according to AISI

i) Cold Work tool steels : -

These steels are used for cold working of metals. They have good hardness and wear resistance at low temperatures. Some of the steels from this group contain very little or no alloying elements and hence are less expensive. They are classified into subgroups such as water hardening, oil hardening, air hardening and high carbon high chromium steels.

ii) Hot work tool steels : -

These steels are mainly used for hot working of metals such as for stamping, drawing forming, piercing, extruding. They have good strength, toughness, hardness and wear resistance at elevated temperatures. They are of low to high alloy content with relatively less carbon (0.35 to 0.65 %) and are classified into three types depending upon the principle alloying element. These are chromium type, tungsten type and molybdenum type hot work tool steels.

iii) High speed tool steels :-

These steels maintain high hardness upto a temperature of about 550^0C and hence can be used for cutting of metals at high speeds. They also have high wear resistance and cutting ability. They are classified into two groups one group is tungsten high speed steels and second group is called molybdenum steels.

iv) Special purpose tools steels :-

The steels under this group are shock resisting tool steels, carbon-tungsten tool steels and mould steels.

Suitable Description – 04 Marks

b) What is carburizing ? State two merits and demerits of carburizing.

The method of increasing the carbon on the surface of a steel is called carburizing. It consists of heating the steel in the austenitic region in contact with a carburizing medium, holding at this temperature for a sufficient period and cooling to room temperature. In the austenitic region, the solubility of carbon is more and hence the carbon from medium diffuses into the steel i.e. in the austenite. High carbon content on surface does not mean high hardness of the surface, unless the carbon is present in the martensitic form. Hence after carburizing hardening treatment is necessary.

Suitable Description – 02 Marks

Merits :- **(Any two ½ M each) – 1 Mark**

i) Hard, wear resistant case and soft, tough core is obtained.

ii) Negligible change in dimension after carburizing.

iii) Uniform case depth can be obtained.

iv) Low cost.

v) Suitable for mass production.

Demerits :- **(Any two ½ M each) – 1 Mark**

i) Sometimes uniform case depth is difficult to obtain.

ii) Skilled personnel are required.

iii) In case of liquid carburizing necessary care is to be taken.

iv) In case of solid carburizing more time required for process.

C) List the special cutting tool materials with its two characteristics.

1) Cemented Carbide : - They can be tailored to give different combinations of abrasion resistance and toughness by varying the amount of cobalt and the tungsten carbide grain size. They are made from carbide powders of refractory metals such as W, Ta, Ti etc and manufactured by powder metallurgy.

2) **Cermets : -** A cermet is a composite of a ceramic material with a metallic binder.

3) Ceramics :- They are made from Al_2O_3. They are more stable than carbide tools at high temperatures, operate best at light loads and high speeds. May be made by sintering.

4) Stellities :- Stellites are cast alloy tools having high hardness. Excellent red hardness, wear resistance and corrosion resistance. They cannot be machined and hence are cast to rough shape followed by grinding to final shape.

(Any two types along with their characteristics 2 Mark to each) – 04 Marks

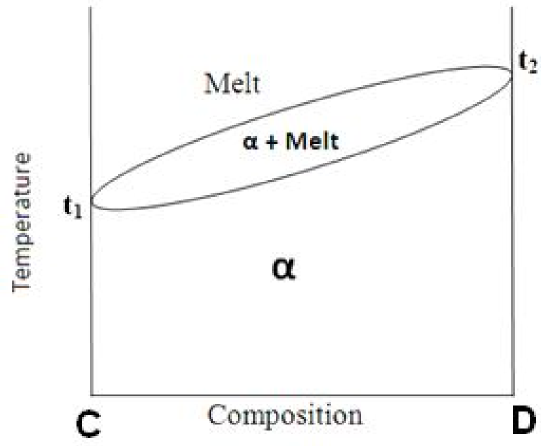
D) Describe with neat sketch isomorphous system.

Isomorphous System :- The simplest of two component or binary, alloy system is the isomorphous system in which only a single type of crystal structure is observed. The alloy system formed between copper and nickel, copper and platinum, copper and gold, gold and silver, iron and vanadium etc.

All alloy system of this type exhibits the following characteristics.

i) No eutectic exists within the system since alloys of every combination form solid solution.

ii) The solid solution formed by the solidification of metals of varying percentage compositions reveal little variation with respect to their mechanical properties.



In the left hand side of the diagram t_1 is the melting point of metal C and t_2 is that of metal D. In α region two metals are so completely dissolved in each other that they cannot be distinguished.

Neat sketch – 01 Mark

Related descriptin – 03 marks

e) Differentiate between martempering and austempering.

Martempering	Austempering
1. Martempering is a hardening treatment. 2. Martempering gives martensite product. 3. More distortion and quenching cracks. 4. Tempering is needed after martempering. 5. It requires less time. 6. Low ductility and toughness obtained.	1. Austempering is not a hardening treatment. 2. Austempering gives bainite product. 3. Less distortion and quenching cracks. 4. Tempering is not needed after austempering. 5. It requires more time. 6. Greater ductility and toughness obtained.

(Any four points 1 M to each) – 04 Marks

f) Describe any one powder making process

.(Suitable description of any one -04 marks)

i) Automisation :- In automisation process a high pressure steam, or liquid impinges on the molten metal which is passed through orifice causing it to automise into fine particles. This method is used for the metal which has low melting point.

ii) Reduction :- In reduction process, the compound of metals are reduced with CO and H_2 gas in controlled atmosphere at temperature below the melting point of the metal. The reduced product is then crushed and ground. Powders of copper, iron, tungsten, molyb denum, nickel are manufactured by the reduction process.

iii) Electrolysis :- Electrolysis is used for the production of metal powder of copper and iron. The process is similar to electroplating, In this process anode and cathode are placed in the electrolyte bath. As anode is going to detoriate, so copper plates are placed at anodes and aluminium plates are placed at cathodes. High intensity current produces deposites of copper powder on cathode plates. Then cathode plates are taken out and scrapped off to collect copper powder.

iv) Crushing :- This is totally mechanical process. The brittle metal or alloy is easily crushed by this method. It requires crushing machinery like stamps, hammer, jaw crusher etc.

v) Milling :- It requires ball mill, impact mill, eddy mill, disk mill or vortex mill. Milling process can be used to hard, soft, ductile or brittle materials. A ball mill is widely used which is horizontal barrel-shaped container holding number of balls which being free to tumble about as the container rotates. Then it crush or grind the material to give fine powder.

Q. 6 a) Compare annealing with normalizing.

Annealing	Normalising
1. Main purpose of annealing is to relieve internal stresses. 2. Coarse pearlite is obtained. 3. Furnace cooling is employed.	1. Main purpose of normalizing is to improve mechanical properties of steel. 2. Fine pearlite is obtained. 3. Air cooling is employed.

4. Cooling rate is slow.	4. Cooling rate is fast.
5. Grain size distribution is more uniform.	5. Grain size distribution is slightly less uniform.
6. More ductility.	6. Less ductility.
7. For hypereutectoid steel the heating range is above A3.	7. For hyper eutectoid steel the heating range is above Acm.
8. Costly and inconvenient.	8. Economical and more convinient.

(Any four points 1 M to each) – 04 Marks

b) How steels are classified ?

1) On the basis of carbon :-

i) Low carbon steels (0.008 – 0.30 % C)

ii) Medium carbon steels (0.30 – 0.60 % C)

iii) High carbon steels (0.60 – 2.00 % C)

2) On the basis of alloying elements :-

i) Low alloy steels : Thses contain alloying elements less than 10%.

ii) High alloy steels : Thses contain alloying elements more than 10%.

3) On the basis of deoxidation :

i) Rimmed steels

ii) killed steels

iii) Semikilled steels

4) On the basis of method of manufacture :

i) Basic open hearth

ii) Electric furnace

iii) Basic oxygen process

iv) Acid open hearth

v) Acid Bessemer

5) On the basis of application :

i) Boiler steel ii) Corrosion & heat resistant steels iii) Deep drawing steels iv)Electrical steels v) Free cutting steels vi) Tool steels vii) structural steels

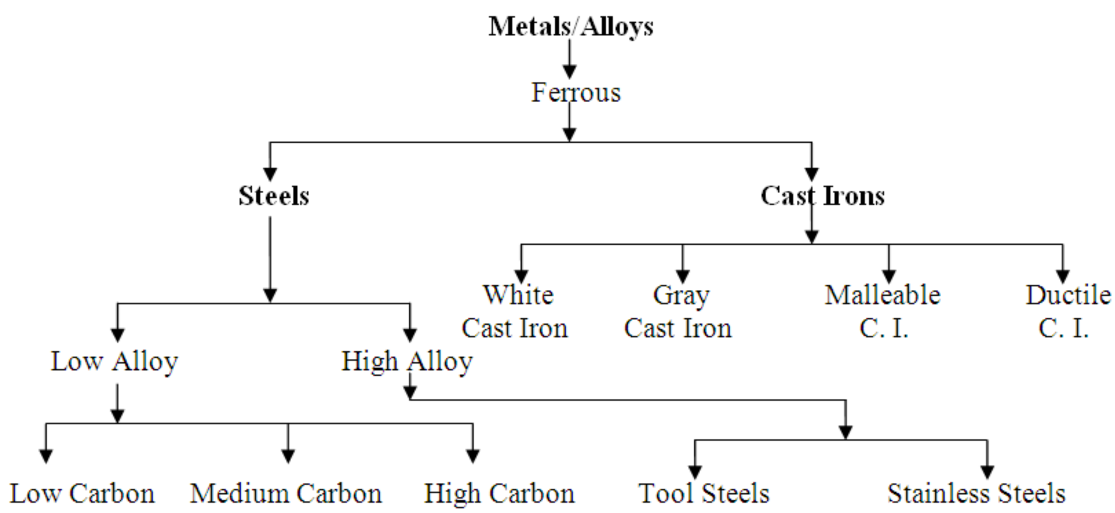
Any four suitable points from above classification 04 marks

c) Define ferrous metals & classify the same.

Ferrous : These materials contain iron as their main constituent. Examples of ferrous metals are iron & steel.

Ferrous materials are the most important metals /alloys in the metallurgical & mechanical industries because of their extensive use. The use of ferrous alloys is widespread because Iron containing compounds exist in abundant quantities within the earth's crust. Also, metallic iron and steel alloys may be produced using relatively economic extraction, refining, alloying and fabrication techniques. Ferrous alloys are extremely versatile in that they may be tailored to have a wide range of mechanical and physical properties. The principal disadvantage of many ferrous alloys is their susceptibility to corrosion.**(02 marks)**

Classification : **.(02 marks)**



d) Differentiate between destructive and non destructive testing

Destructive Testing	Non destructive Testing
1. The component breaks or damages during or after testing the component. 2. The component is not useful for further purpose 3. Properties like tensile strength, compressive strength, bending strength, fatigue strength, toughness, ductility can be assessed. 4. 100% inspection is not possible. 5. Not economical and safe. 6. Engineers get more useful information regarding designing of the component. 7. Examples :- Tensile test, compression test, impact test, bend test, torsion test, fatigue test.	1. The component does not break or damage even after testing the component. 2. The component can be used for the purpose it was made. 3. It can detect surface or subsurface defects like cracks, porosity, inclusion blow holes, flaws, cavities etc. 4. 100% inspection is possible. 5. More economical and safe. 6. By this test whether a component to be accepted or rejected can be decided. 7. Examples :- Radiography (X ray or γ rays) ultrasonic inspection, dye penetrate test, magnetic inspection test.

(Any four points, 01 mark to each point)

e) Give the chemical composition of the following copper alloys.

i) Naval brass ii) Muntz Metal iii) Gun Metal iv) Bronze

i) Naval Brass :- Brass with 39 % zinc.
01 % tin
60 % copper

ii) Muntz metal :- It contains 40 % zinc
with balance 60 % copper

iii) Gun metal :- It contains about 10% tin

02 % zinc

88% copper

iv) Bronze :-

Aluminium Bronze :- Alloys of copper and aluminium it contains 4 to 11 % aluminium and remaining copper.

Tin Bronze :- Alloys of copper and tin the soluibility of tin in copper is 1 % at room temperature.

Beryllium Bronze :- Alloys of copper and beryllium.

Silicon Bronze :- The alloys of copper and silicon are called silicon Bronze, silicon content in these alloys varies from 1 to 5.5 %

(Composition of any one type of bronze is sufficient)

(01 mark to each copper alloy)

f) What do you mean by case hardening / state its advantages.

Various machine components like cams, gears,shafts, etc require a hard wear resistant surface and a relatively soft,tough and resistant inside ,called a core. Both these requirements may be achieved by employing a low carbon steel having soft , tough core and then adding carbon, nitrogen or both to the surface of the component to provide a hard case. This treatment is known as case hardening.

case hardening is a technique whereby both surface hardness and fatigue life are enhanced for steel alloys. This is accomplished by a carburizing or nitriding process whereby a component is exposed to a carbonaceous or nitrogenous atmosphere at a elevated temperature. **(02 Marks)**

Advantages : **(any four advantages, ½ mark each)**

1. Hard wear resistant case and soft,tough core is obtained .
2. Most of the methods suitable for mass production .
3. Good corrosion & wear resistance.
4. Good fatigue resistance.
5. Uniform case depth can be obtained.
6. Negligible change in dimension after case hardening.