



**MODEL ANSWER**

**WINTER- 17 EXAMINATION**

**Subject Title: MECHANICAL ENGG. MATERIALS**

Subject Code:

**17303**

**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. No.	Sub Q. N.	Answer	Marking Scheme
1	a)	<b>Attempt any ten.</b> <b>Define creep and fatigue.</b> Creep (sometimes called cold flow) is the tendency of a solid material to move slowly or deform permanently under the influence of mechanical stresses. It can occur as a result of long-term exposure to high levels of stress that are still below the yield strength of the material. Creep is more severe in materials that are subjected to heat for long periods, and generally increases as they near their melting point. fatigue is the weakening of a material caused by repeatedly applied loads. It is the progressive and localized structural damage that occurs when a material is subjected to cyclic loading.	<b>20</b>  1 mark for each definition.
	b)	<b>What is pearlite ?</b> Pearlite is a two-phased, lamellar (or layered) structure composed of alternating layers of ferrite (88 wt%) and cementite (12 wt%) that occurs in some steels and cast irons. During slow cooling of an iron-carbon alloy, pearlite forms by a eutectoid reaction as austenite cools below 727 °C (1,341 °F) (the eutectoid temperature).	2m
	c)	<b>Write four advantages of alloy steel.</b> 1. These steels have greater strength, hardness, hot hardness. 2. Higher wear resistance, high hardenability, or toughness compared to carbon steel. 3. Lower corrosion resistance. 4. wide range of applications.	½ each



	However, they may require heat treatment in order to achieve such properties.	
d)	<p><b>State the objectives of heat treatment.</b></p> <ol style="list-style-type: none"><li>1. improved machinability.</li><li>2. to relieve internal stresses.</li><li>3. improve mechanical properties such as ductility, strength, hardness, toughness etc.</li><li>4. change in grain size.</li><li>5. increase resistance to heat and corrosion.</li><li>6. modify electrical and magnetic properties.</li><li>7. change the chemical composition.</li><li>8. to remove gases.</li></ol>	Any four, ½ m each
e)	<p><b>Define carburizing.</b></p> <p>Carburizing is the process of introducing the carbon in the outer case of low carbon steels in order to produce a hard martensitic structure in the outer surface, after hardening. Carbon content in the outer case is increased by process of absorption and diffusion. It consists of heating the steel in austenitic region in contact with carburizing medium, holding for sufficient time, and cooling to room temperature. In austenitic region, solubility of carbon is more, hence carbon diffuses into austenite.</p>	2m
f)	<p><b>Classify the steel.</b></p> <ol style="list-style-type: none"><li>1. unalloyed steel or plain carbon steels.</li></ol> <p>Unalloyed steels are subdivided into:</p> <ol style="list-style-type: none"><li>(a) Low carbon steels which contain less than 0.30 % carbon</li><li>(b) Medium carbon steels which contain from 0.30 % to 0.60 % carbon</li><li>(c) High carbon steels which contain more than 0.60 % carbon.</li></ol> <ol style="list-style-type: none"><li>2. alloy steels.</li></ol> <p>Alloy steels are subdivided into:</p> <ol style="list-style-type: none"><li>(a) Low alloy steels which have a total alloy content less than 5 %</li><li>(b) High alloy steels which have a total alloy content greater than or equal to 5 %.</li></ol>	1 mark each
g)	<p><b>Write applications of high carbon steel.</b></p> <p>forging dies, punches, hammers, springs, clutch discs, car bumpers, chisels, vice jaws, shear blades, drills, leaf springs, knives, razor blades, balls and races of ball bearings, mandrels, cutters, files, reamers, wire drawing dies, metal cutting saws.</p>	Any four, ½ each.
h)	<p><b>State the meaning of 45cr9si4.</b></p>	2m

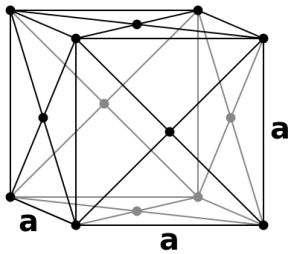


i)	<p>It is medium alloy steel with 0.45 % Carbon, 2.25 % Chromium and 1% silicon.</p> <p><b>Write the application of duralumin.</b></p> <ol style="list-style-type: none"><li>1. Duralumin is widely used in the aircraft industry. in wrought condition used for forging, stamping, bars, sheets, tubes and rivets.</li><li>2. It is used for making wire, bar and rods for the screw machine products. It is used in places where good strength and good machinability are required.</li><li>3. It is used in heavy-duty forgings, wheels, plates, extrusions, aircraft fittings, space booster tanks and truck frame, and other suspension components. It finds applications in places where high strength is required, and services at elevated temperatures.</li><li>4. It is used for making Aircraft structure, truck wheels, screw machine products, rivets and other structural application products.</li><li>5. It is used as a sheet for the auto body panels.</li><li>6. It is also used in forgings, in aircraft engine pistons, impellers of the jet engines and the compressor rings.</li><li>7. It is also used for making die and hand forgings.</li></ol>	Any four, ½ m each
j)	<p><b>What is acrylic? State its applications.</b></p> <p>acrylic (polymethyl methacrylate(PMMA))</p> <p>Acrylic is a synthetic form a polymer (polyacrylonitrile) .For a fiber to be called "acrylic" in the US, the polymer must contain at least 85% acrylonitrile monomer. Typical comonomers are vinyl acetate or methyl acrylate.</p> <p>applications:</p> <p>contact lenses, glazing fluorescent light diffusers, rear light covers for vehicles. name plates,sink, bath, hopital equipments etc.</p>	Description 1m, Any 2 Applications 1m.
k)	<p><b>What is sintering?</b></p> <p>Sintering is the process of compacting and forming a solid mass of material by heat or pressure without melting it to the point of liquefaction.</p> <p>Sintering happens naturally in mineral deposits or as a manufacturing process used with metals, ceramics, plastics, and other materials. The atoms in the materials diffuse across the boundaries of the particles, fusing the particles together and creating one solid piece. Because the sintering temperature does not have to reach the melting point of the material, sintering is often chosen as the shaping process for materials with extremely high melting points such as tungsten and molybdenum. This is an important step in powder metallurgy.</p>	2m
l)	<p><b>State the limitations of powder metallurgy.</b></p>	Any two, 1m each.

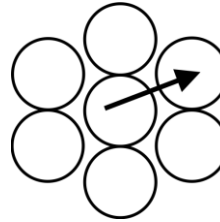


2	<p>a)</p> <p>b)</p> <p>c)</p>	<p>1. many metal powders are explosive at room temperature.</p> <p>2. some metals are difficult to compress, since they tend to cold- weld to the walls of the die, thus causes excessive wear on the die.</p> <p>3. parts pressed from the top tend to be less dense at the bottom, thus density variation occurs.</p> <p>4. there are design limitations on the die as regards of p/m process.</p> <p>5. Large sized components cannot be manufactured</p> <p>6. Poor corrosion resistance for p/m products due to porosity</p> <p><b>Attempt any four.</b></p> <p><b>Give the characteristics of ferrous metals.</b></p> <ul style="list-style-type: none"> <li>• They have higher tensile strength and durability.</li> <li>• They have lustrous finish and metallic sound.</li> <li>• Most ferrous metals have good magnetic and electrical properties which makes them useful for large motors and electric appliances.</li> <li>• Due to high amounts of carbon they are vulnerable to rust when exposed to elements.</li> <li>• Mostly used in housing construction, industrial applications, large scale piping, rail for railroad, tools and hardware.</li> </ul> <p><b>How metals are classified? Name any two types of CI.</b></p> <p>Metals are classified according to principle ingredient in them.</p> <div style="text-align: center;"> <p><b>METALS</b></p> <p>SHOWS "METALLIC BONDS" BASICALLY CRYSTALLINE IN NATURE. SHOWS "METALLIC PROPERTIES"</p> <pre> graph TD     METALS[METALS] --&gt; FERROUS[FERROUS METALS AND ALLOYS]     METALS --&gt; NONFERROUS[NONFERROUS METALS &amp; ALLOYS]     FERROUS --- FERROUS_DESC[CONTAINS IRON AS MAIN ELEMENT. IRON, STEELS, CAST IRONS (IRON+CARBON) ARE EXAMPLES]     NONFERROUS --- NONFERROUS_DESC[DOES NOT CONTAIN IRON AS MAIN ELEMENT. COPPER, SILVER, ALUMINIUM, BRASS (COPPER+ZINK), BRONZES ARE EXAMPLES]         </pre> </div> <p>Types of CI: Gray CI, white CI, malleable CI, nodular CI or SG cast iron.</p> <p><b>Give typical slip planes and direction of FCC and BCC metals.</b></p>	<p>16</p> <p>Any four , 1m each</p> <p>Classification 2m, types 2m</p> <p>Fcc 2m, bcc 2m.</p>
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Face centered cubic crystals



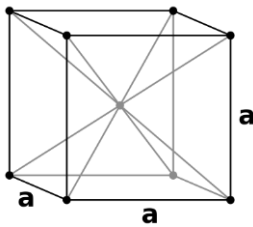
FCC unit cell.



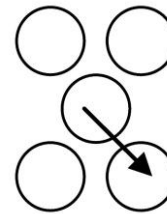
Lattice configuration of the close packed slip plane in an fcc material. The arrow represents the burgers vector in this dislocation glide system.

Slip in face centered cubic (fcc) crystals occurs along the close packed plane. Specifically, the slip plane is of type  $\{111\}$ , and the direction is of type  $\langle 110 \rangle$ . In the diagram on the right, the specific plane and direction are  $(111)$  and  $[110]$ , respectively.

Body centered cubic crystals



BCC unit cell.



Lattice configuration of the slip plane in a bcc material. The arrow represents the burgers vector in this dislocation glide system.

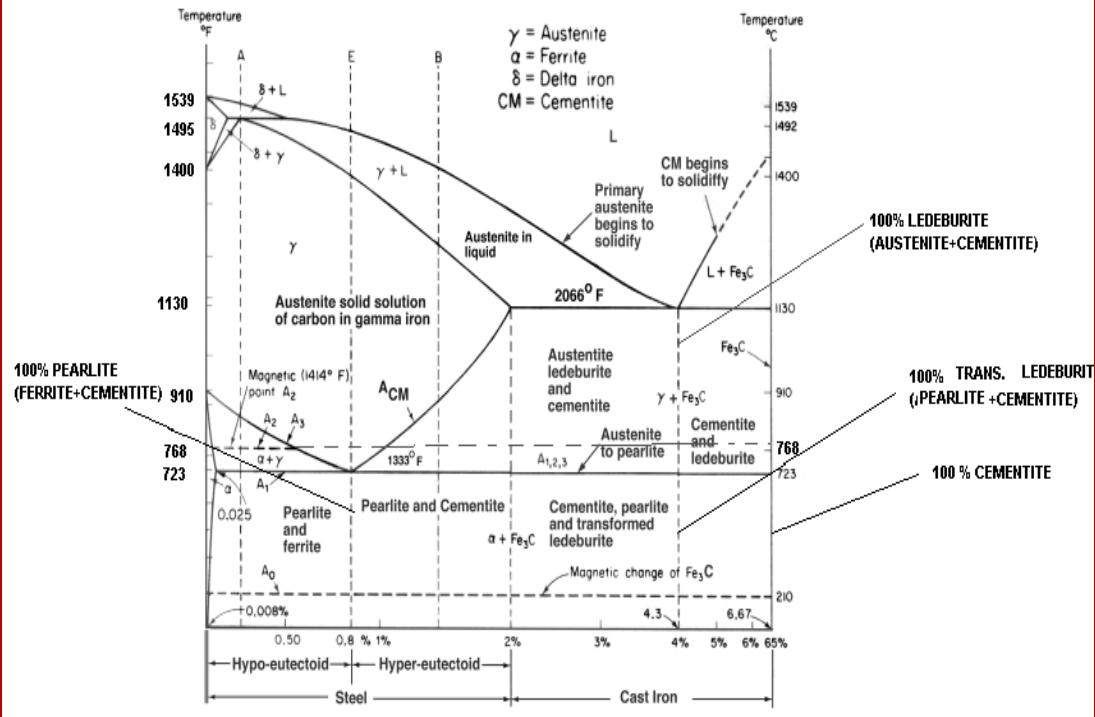
Slip in body-centered cubic (bcc) crystals occurs along the plane of shortest Burgers vector as well; however, unlike fcc, there are no truly close-packed planes in the bcc crystal structure. Thus, a slip system in bcc requires heat to activate. Some bcc materials (e.g.  $\alpha$ -Fe) can contain up to 48 slip systems. There are six slip planes of type  $\{110\}$ , each with two  $\langle 111 \rangle$  directions (12 systems). There are 24  $\{123\}$  and 12  $\{112\}$  planes each with one  $\langle 111 \rangle$  direction (36 systems, for a total of 48). While the  $\{123\}$  and  $\{112\}$  planes are not exactly identical in activation energy to  $\{110\}$ , they are so close in energy that for all intents and purposes they can be treated as identical.

In the diagram on the right the specific slip plane and direction are  $(110)$  and  $[111]$ , respectively.

d)

**Draw i-c equilibrium diagram and label it.**

Sketch 2m,  
label 2m.



e) **Write the properties and applications of Wrought iron.**

Properties :

Very low carbon percent about 0.03%.

It is soft, ductile and magnetic.

High elasticity and tensile strength (234 -372 MPa). but Shears easily.

It can be reheated and worked into various shapes.

It can be welded.

Presence of oxides and or inclusions creates defective results.

Applications:

- Decorative items such as railings, outdoor stairs, fences and gates
- Nuts and bolts
- Handrails.

f) **Define pig iron. State the types of pig iron with their properties.**

Pig iron is semi finished (crude iron) produced from Iron ore in blast furnace, containing 92 % iron also known as haematite pig iron, high amounts of carbon typically up to 3.5 % and balance largely manganese and silicon plus small amounts of phosphorus, sulphur and other impurities.

pig iron comprises three main types:

1. basic pig iron: used mainly in electric arc steelmaking
2. foundry pig iron (also known as haematite pig iron): used in mainly in the

Properties 2m,  
applications  
2m

Definition 2m,  
types 2m.



3	a	<p>manufacture of grey iron castings in cupola furnaces</p> <p>3. high purity pig iron (also known as nodular pig iron): used in the manufacture of ductile [also known as nodular or spheroidal graphite – SG] iron castings.</p> <p><b>Define annealing. State its purpose and explain how full annealing is carried out.</b></p> <p>Annealing:- Annealing may be defined as the heat treatment in which steel is heated to austenitic region and then cooling slowly in transformation range.</p> <p>Purpose of Annealing :</p> <ul style="list-style-type: none"><li>• To improve homogeneity of steel.</li><li>• To alter microstructure to improve properties of steel.</li><li>• To restore ductility.</li><li>• To refine the grain size.</li><li>• To relieve the internal stresses in steel.</li><li>• To improve machinability of steel.</li><li>• To reduce strain hardening effect of cold working. this increases ductility.</li></ul> <p>Full annealing : conventional or full annealing may be defined as the heat treatment process in which the given steel is heated to annealing temp. range, hold for some time and there after cooled slowly in the furnace by switching off the furnace leading to formation of coarse pearlitic structure in the steel.</p> <p>Following are steps in full annealing,</p> <p>1.heating steel to annealing temperature range. for plain carbon steels this range is, A3 + 50 for hypo eutectoid steels. A1 + 50 for eutectoid steel. A1 + 50 for hyper eutectoid steels</p> <p>2.holding the steel for equalization of temp. Across cross section. The holding time is a function of following factors,</p> <ul style="list-style-type: none"><li>• Type of steel.</li><li>• Size and cross sectional area of steel part.</li></ul> <p>4. Cooling the steel slowly to room temperature to room temperature by switching off the furnace Due to slow cooling the austenite is transformed into “coarse pearlite.</p>	<p>Definition of annealing---1M</p> <p>Purpose of annealing--- Any two—1M</p> <p>Full annealing—2M</p> <p>Any Four points-----4M</p>
	b	<p><b>Compare flame hardening and induction hardening process</b></p>	



<p><b>FLAME HARDENING</b></p> <ul style="list-style-type: none"> <li>• surface of steel is heated rapidly by oxyacetylene flame , then quenching to convert austenite into martensite</li> <li>• Success depends on skill of operator.</li>   <li>• Suitable for large shaped components or irregular shape components.</li> <li>• Internal surfaces may be heated and hardened</li> <li>• Cheaper method</li> <li>• Applications:-Large gear shafts, lathe ways, spline shaft etc</li> </ul> <p><b>OPERATING VARIABLES ARE</b></p> <ul style="list-style-type: none"> <li>• distance between flame &amp; work piece.</li> <li>• gas pressure,</li> <li>• flame or work travel rate,</li> <li>• type, volume and application of quench.</li> <li>• any shaped parts are suitable for</li> </ul>	<p><b>INDUCTION HARDENING</b></p> <ul style="list-style-type: none"> <li>• steel is heated by high freq. electric induction current and cooled rapidly to convert austenite into martensite</li> <li>• Success is related to selection and design of proper work coil.</li> <li>• Suitable for round shaped components</li>   <li>• Internal surfaces are difficult to heat.</li> <li>• Costly method</li> <li>• Applications:-Piston rods, cams, shafts etc</li> </ul> <p><b>OPERATING VARIABLES ARE</b></p> <ul style="list-style-type: none"> <li>• induced voltage</li> <li>• flow of current</li> <li>• resistance offered by work</li> <li>• shape and design of coil &amp;</li> <li>• rate of heating.</li> <li>• irregular shaped parts are</li> </ul>
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c

**State advantages and limitations of tempering.**

**Advantages**

- internal stresses produced during hardening gets relieved
- Reduction in hardness.
- Improvement in ductility and toughness.
- Reduction in retained austenite.
- Spheroidal structure is obtained which improves machinability.

**Limitations**

- Tempering reduces hardness of steel
- Tempering reduces strength of steel
- Sometimes tempering induces temper brittleness in alloy steel on slow cooling

d

**Explain the principles of heat treatment.**

Heat treatment process is used to change the external properties of material by changing its internal microstructure. The external properties of material like tensile strength, impact strength, ductility, hardness depends upon the internal microstructure of the material. The internal microstructure can be change by using heat treatment process by adopting different rates of cooling. Heat treatment is effective only with certain alloys because it depends upon, one element being soluble in another in the solid state in different amounts under different circumstances. Steel heat treatments are made possible by the eutectoid reaction in iron carbon diagram.All basic heat treating processes for steel involve the transformation of austenite

Advantages-2M

Limitations-2M

Suitable Description -4M



heat treatment brings following changes

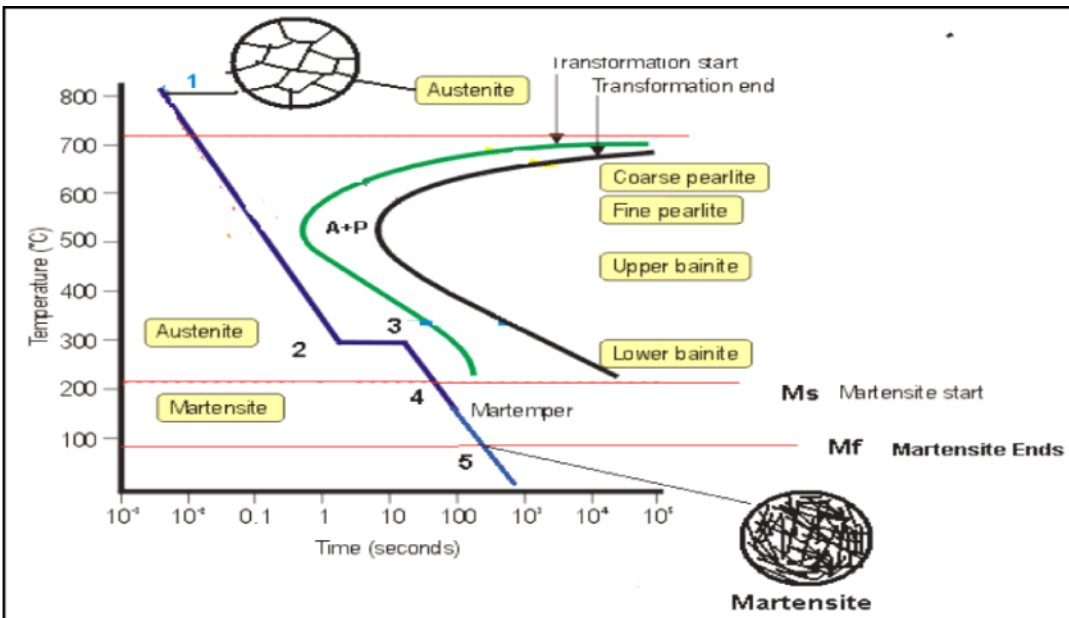
- i) Relieving internal stresses developed during cold working, welding, casting, forging, etc
- ii) Improve machinability and corrosion resistance
- iii) change in grain size
- iv) improve hardness, ductility and toughness
- v) improve electrical and magnetic properties

e

**What is martempering? Explain**

Martempering:-

- Practically a hardening process.
- Steel is heated to austenitizing temp, then rapidly cooled in salt bath kept at a temp. Just above Ms.
- Holding time should be such that austenite should not transform to bainite.
- It is then cooled to room temp. In air or oil to obtain martensite.
- Holding in constant temp. bath equalizes temperature from surface to centre and minimizes warping and quenching cracks
- Since the component has to be held for some time for equalization of temperature, the process is applicable to steels of high hardenability such as high carbon steels & low alloy steels
- It results in less distortion and warping
- There is less possibility of quenching cracks appearing in the component
- 



Suitable Description -3M (Diagram 1 mark)

f

**What is Nitriding? What are its advantages and limitations?**

**NITRIDING**

- 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.

Description 1M, Any three advantages 1/2 Mark each, any three disadvantage 1/2 Mark each.

- 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.
- hard outer surface is formed without quenching.
- maximum case depth achieved is around 0.03 mm to 0.6 mm.

#### advantages of nitriding

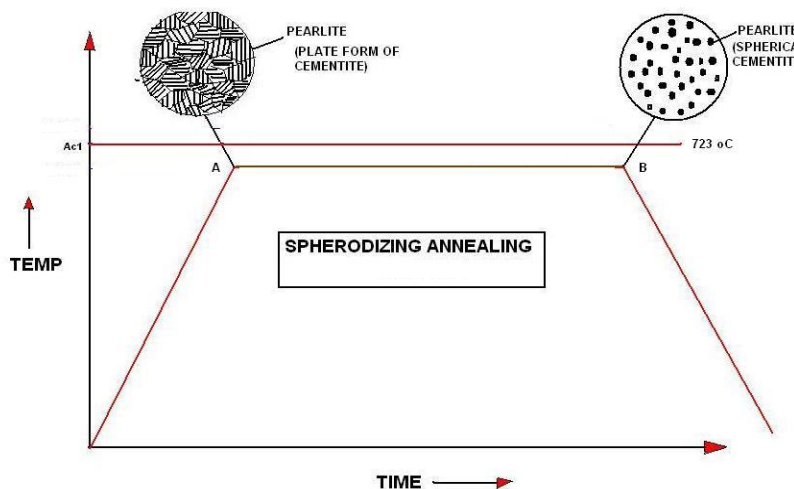
- high corrosion resistance
- increased fatigue resistance.
- very hard outer layer
- wear resistance.

#### disadvantages of nitriding

- long cycle times (25 to 100 hrs)
- brittle case
- only special alloy steels containing Al, Mo, V, Cr as alloying elements can only be nitrided.
- plain carbon steels cannot be effectively nitrided.
- high cost.
- technical control required.
- if nitrided part gets accidentally overheated. (above 500 °C) then the hardness will be lost completely.

#### Explain Spheroidising with its advantages.

spheroidizing annealing : -spheroidizing annealing is done to improve the “machinability” of the steel. -here plate form of cementite is converted into globular or spherical form of cementite. -effective for high carbon steels, high carbon tool steels, all alloy steels, ball bearing steels. following two methods are used. prolonged holding below  $ac_1$  temp: here the steel is heated below  $ac_1$  temp. & held at this temperature for prolonged period of time (6 to 7 hrs) to convert plate form of cementite into globular or spherical form of cementite.



#### Advantages:-

- Spheroidised structures are softest than annealed structures
- Spheroidised structures have excellent machinability
- The time of hardening is greatly reduce

Explanation  
(Sketch preferred.)  
3M, advantages  
any two 1M.

4


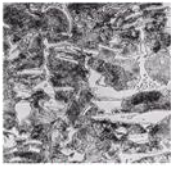

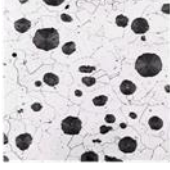
a



b	<ul style="list-style-type: none"> <li>It reduces oxidation &amp; decarburization</li> </ul> <p><b>Differentiate between white cast iron and Grey cast iron</b></p> <table border="1"> <thead> <tr> <th>white cast iron</th> <th>gray cast iron</th> </tr> </thead> <tbody> <tr> <td> <ul style="list-style-type: none"> <li>It shows a white fracture</li> <li>It contains whole of the carbon in combined(carbide )form</li> <li>Mn encourages formation of carbides.</li> <li>High wear resistant</li> <li>It is more hard</li> <li>Hardness varies from 400 to 600 BHN</li> <li>It can not be machined</li> <li>Application-wearing plates, pump liners, grinding balls</li> </ul> </td> <td> <ul style="list-style-type: none"> <li>It shows a gray fracture</li> <li>It contains whole of the carbon in free graphite form</li> <li>Si encourages formation of carbides.</li> <li>Low wear resistance.</li> <li>It is less hard</li> <li>Hardness varies from 140 to 240 BHN</li> <li>It can be machined</li> <li>Applications-Used in machine tool structure, pump body</li> </ul> </td> </tr> </tbody> </table>	white cast iron	gray cast iron	<ul style="list-style-type: none"> <li>It shows a white fracture</li> <li>It contains whole of the carbon in combined(carbide )form</li> <li>Mn encourages formation of carbides.</li> <li>High wear resistant</li> <li>It is more hard</li> <li>Hardness varies from 400 to 600 BHN</li> <li>It can not be machined</li> <li>Application-wearing plates, pump liners, grinding balls</li> </ul>	<ul style="list-style-type: none"> <li>It shows a gray fracture</li> <li>It contains whole of the carbon in free graphite form</li> <li>Si encourages formation of carbides.</li> <li>Low wear resistance.</li> <li>It is less hard</li> <li>Hardness varies from 140 to 240 BHN</li> <li>It can be machined</li> <li>Applications-Used in machine tool structure, pump body</li> </ul>	Any Four points-----4M
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c	<p><b>State any four properties and uses of stainless steel.</b></p> <p><b>Properties of stainless steel</b></p> <p>i)High corrosion resistance ii) High ductility &amp; formability iii)Excellent surface finish iv)Good creep resistance v) Good thermal resistance vi)Easy weldability vii) Good machinability viii) High resistance to oxidation</p> <p><b>Uses of stainless steel</b></p> <p>Utensils ,Chemical And Food Pressing Equipments, Air Craft Exhaust Manifolds, Boiler Shells, Shafts , Valves ,Furnace Parts, Nozzle, Combustion Chambers, Steam Turbine Blades, M/C Parts ,Pump Shafts, Spring, Valves, Surgical Instruments, Ball Bearings Races etc</p>	<p>Any four Properties 1/2 mark to each-----2Mark</p> <p>Any four Uses 1/2 mark to each-----2Mark</p>				
d	<p><b>State the effect of following alloying elements on steel.</b></p>					



<p>e</p>	<p>i) Phosphorus</p> <ul style="list-style-type: none"><li>Increases tensile strength &amp; hardness of steel</li><li>Increases machinability of steel</li><li>Addition in large amount increases the brittleness and cold shortness of steel</li></ul> <p>ii) Sulfur (S)</p> <ul style="list-style-type: none"><li>Imparts brittleness</li><li>Improves machinability</li><li>Okay if combined with Mn</li><li>Some free-machining steels contain 0.08% to 0.15% S</li></ul> <p>iii) Silicon</p> <ul style="list-style-type: none"><li>Increases strength, hardness &amp; toughness without loss of ductility</li><li>Increases permeability of steel &amp; reduces hysteresis losses</li><li>Added in molten steel for deoxidation</li></ul> <p>iv) Chromium (Cr)</p> <ul style="list-style-type: none"><li>Usually &lt; 2%</li><li>increases strength</li><li>Offers corrosion resistance by forming stable oxide surface</li><li>typically used in combination with Ni and Mo</li><li>increases hardness, hardenability and wear resistance of steel. It increases red hardness of steel. Increases corrosion &amp; oxidation resistance of the steel.</li></ul> <p><b>What do you mean by 18:4:1 tool steel? Where it is used?</b></p> <p>18:4:1 Tool steel—</p> <p>Tool steel is used for making various types of cutting tools &amp; press tools. 18:4:1 is a high speed tool steel. These steels maintain high hardness up to a temperature of about 550 degree and hence can be used for cutting of metals at high speeds. They also have high wear resistance and cutting ability. 18:4:1 steel contains 0.7% C, 18% W, 4% Cr and 1% V. It possesses red hardness means it maintains hardness at high temperature. These are characterized by high hardness (60-65 HRC at 600-650°C), high red hardness, wear resistance, reasonable toughness and good hardenability 18-4-1 (t1 grade) hss: is austenitized at 1280 °C, salt quenched to 608</p>	<p>1M for effect of each alloying element---4M</p> <p>Description of 18:4:1 steel---3M</p>
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5	f	<p>0c, air cooled and double tempered at 540 0c. Microstructure shows white spots of undissolved carbides in a matrix of tempered martensite. The presence of wear resistant carbides in a hard heat resistant matrix makes these steels suitable for cutting tool applications.</p> <p>Uses OF HSS: used for making various types of cutting tools such as Tool Bits, Drills, Reamers , Broaches, Taps, Milling Cutters, Hobs, Saws, Wood Working Tools.etc</p> <p><b>State the types of cast iron and draw the microstructure of the same</b></p> <p><b>Types</b></p> <p>i) White cast iron ii) Gray cast iron iii) Malleable cast iron iv) Nodular cast iron v) Chilled cast iron vi) Meehanite cast iron</p> <p><b>Microstructure</b></p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>Gray iron</p> </div> <div style="text-align: center;">  <p>White iron</p> </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;">  <p>Malleable iron</p> </div> <div style="text-align: center;">  <p>Ductile iron</p> </div> </div>	<p>Uses --1M</p> <p>Types—Any four 1/2M each—2M</p> <p>Microstructure-----1/2 M each-----2M</p>
	a	<p><b>Attempt any Four of the following.</b></p> <p><b>Give IS specifications for i. Grey Cast Iron ii. Tool Steel</b></p> <p>Ans : i) Grey Cast Iron : Grey cast Irons are specified BY IS 4843:1968 as under AFG 200 – Grey cast Iron with minimum tensile strength of 200 MPa AFG 400 - Grey cast Iron with minimum tensile strength of 400 MPa</p> <p>ii) Tool Steel : Tool steels are specified as under, T70W18Cr4V1 – Tool steel with 0.70% carbon, 18 % Tungsten , 4 % Chromium and 1 % Vanadium T83 MO6 V6 Cr 4 V2 - Tool steel with 0.83% carbon, 6% Molybdenum, 6%</p>	<p>02 Marks</p> <p>02 Marks</p>



b	<p>Tungsten , 4 % Chromium and 2 % Vanadium</p> <p><b>Give properties of Bearing Metals</b></p> <p>Ans: a. Should have low coefficient of friction b. Should have high fatigue strength c. Should have high corrosion resistance d. Should have high compressive strength e. Should be hard and Wear resistant f. Should be tough and shock resistant. g. Should be self lubricated property</p>	04 Marks (any 4)
c	<p><b>What is Copper ? State its properties and applications</b></p> <p>Ans: Copper is a non ferrous metal with symbol Cu and atomic number 29. It has reddish – Orange colour. Copper has following important properties,</p> <ul style="list-style-type: none"><li>• Crystalline, non magnetic and reddish in colour.</li><li>• High electrical and Thermal conductivity.</li><li>• Malleable and Ductile.</li><li>• Good corrosion resistance.</li><li>• Light in weight.</li><li>• Can be cold worked i.e. rolled, deep drawn.</li></ul> <p>Applications-Electrical conductors, bus bars, automobile radiators, utensils, coins</p>	Properties-2 Applicatons-2
d	<p><b>Give composition and two applications of Gun Metal</b></p> <p>Ans: Gun metal is an alloy of Copper ,Tin and Zinc with 88% copper, 8-10% Tin and 2-4% Zinc with lead is an approximation composition. Typical compositions of Gun metal in use are as under,</p> <ol style="list-style-type: none"><li>85/5/5 Gun Metal : Contains 85% copper, 5% of Tin ,Zinc and lead</li><li>88/10/2 Gun metal : Contains 88% copper, 10% Tin and 2% Lead.</li></ol> <p>Applications of gun metal are as under,</p> <ul style="list-style-type: none"><li>• Used for making Light duty castings</li><li>• Heavy bearings</li><li>• Gun barrels</li></ul>	Properties-2 Applicatons-2
e	<p><b>State characteristics and applications of ABS</b></p> <p>Ans: <b>Characteristics of ABS are as under,</b></p> <ul style="list-style-type: none"><li>• ABS plastics are copolymers of acrylonitrile butadiene and styrene.</li><li>• Resistant to acids , alkalis and to some organic solvents.</li><li>• Good Strength and Toughness.</li><li>• Hard and Rigid.</li><li>• Good insulators to heat and electricity.</li><li>• Good Impact resistance.</li></ul> <p><b>Applications of ABS are as under,</b></p> <ul style="list-style-type: none"><li>• Automobile panels and parts.</li><li>• Radiator Grills.</li><li>• TV Cabinets and cameras</li><li>• Telephones</li><li>• Refrigerator Liners.</li></ul>	02 Marks  02 Marks
F	<p><b>Explain Laminated Composites and Fibre reinforced composites</b></p>	



Ans: Layered composites are called as laminates. Examples are as under,

a. 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 fibreboard (MDF) and particle board (chipboard).

b. Copper stainless steel laminates

c. Laminated Plastic sheets

d. TUFNOL: Layers of woven textiles bonded with thermosetting resin, providing high tensile strength and rigidity. (Any two example of above with applications)

1. Glass Fibre reinforced Plastic: This is the plastic reinforced with fine fine glass fibres. 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 include, aircraft, boats, automobiles, bath tubs and enclosures, hot tubs, septic tanks, water tanks, roofing, pipes, cladding, casts, surfboards, and external door skins. (Any two example of above with applications)

02 Marks

02 Marks

6

a

**Attempt any Four of the following.**

Differentiate between thermoplastic and thermosetting Plastics.

Thermo plastics	Thermosetting Plastics
1.Composed of chain molecules	1.Composed of cross linked molecules
2.Can be repeatedly softened by heat and hardened by cooling	2.Can be softened only first time When Heated. But cannot be softened on subsequent cooling
3. Comparatively softer and less strong	3.Stronger and Harder
4.Cannot be used at Higher Temperatures	4.Can be used at Higher Temperatures
5.Produced by additional Polymerization and	5.Produced by Condensation Polymerization.
6.Can be easily Moulded and remoulded Into Any shape	6. Cannot be moulded and Remoulded into new shape.

(Any four correct points --  
- 04 Marks)

7. Used for Toys, combs, toilet goods, tapes  
Hoses, pipes

7.Used for Telephone  
receivers, cabinets Camera bodies.

b

**Give two applications in industry of i) Polysters and ii) Epoxies**

Ans : i) Industrial applications of Polysters are as under,

- Bodies of car, Refrigerators and Washing Machines
- Helmets, Fans and Boat Hulls

ii) Industrial applications of Epoxies are as under,

- Laminates, Adhesives, electronics / electrical components/LED, master models, laminates, castings, fixtures
- Insulating materials for electrical applications, Protective coatings

(Any four correct applications --- 04 Marks)

c

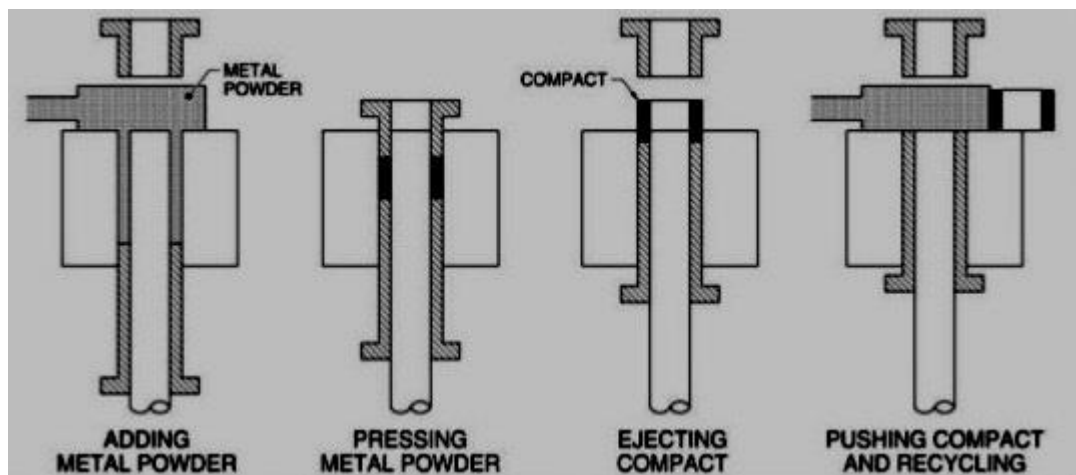
**Explain compacting process in powder metallurgy**

Ans: Powder pressing is the compaction of powders into a geometric form. Pressing is usually performed at room temperature. This creates a solid part called a green compact. The strength of this pressed, unsintered part, (green strength), is dependent on compactability, binders may be used to increase compactability. Typically a green compact can be broken apart by hand but is also strong enough to be handled, gently. The geometry of the green compact is similar to that of the final part, however, shrinkage will occur during the sintering phase of the manufacturing process. a green compact has a certain amount of lubricants and binders in it that add extra material. During sintering, these lubricants and binders are burned off.

To begin the manufacturing process, a certain amount of powder is filled into a die. Rate of die filling is based largely on the flowability of the powder. Powders that flow readily can be poured at higher rates. Pouring can be an automated process.

Once the die is filled, a punch moves towards the powder. The punch applies pressure to the powder, compacting it to the correct geometry. A simple illustration of the pressing process is shown in figure.

( Correct points with figure --- 04 Marks)







Amount of force necessary for a pressing operation is to a large degree based on material. For example, pressing aluminum powder generally requires lower force, while pressing iron powder requires relatively higher force. Pressing force also depends upon powder characteristics, additives and desired density of the green compact. Friction force will oppose movement of particles during pressing, therefore lubrication can reduce the required pressing force and also cause a more uniform distribution of particles during pressing. Lubrication should be applied in the correct quantities. Excessive lubrication will not all remain on particle surfaces, but will also collect in the interparticle spaces, (open pores), and prevent the proper compaction of powder. Pressing force is a function of pressure over the area of the part perpendicular to the direction of pressing. Usually the press is vertical, in this case the horizontal plane of the part would be considered.

d

**Differentiate between Destructive and Non Destructive Testing**

<b>Destructive Testing</b>	<b>Non Destructive</b>
1.Components are destructed during test during test	1.No destruction of components
2.Components cannot be used for another test	2.Component can be used for another test
3.Test gives mechanical Properties	3. Test gives defects located within components
4. Cost of test is less	4.Cost of test is high
5. Special Test samples needed for test tested	5. Components can be directly tested
6.Ex-Tensile, compressive, fatigue test	6.Ex-X-Ray, Magna flux

e

**Why different alloying elements are used in steel ? Explain with suitable example.**

Ans: Various alloying elements are added in the alloy steels for following reasons

- To increase yield strength and tensile strength of steel.
- To increase hardenability of steel.
- To increase wear resistance of steel.
- To increase creep resistance of steel.
- To increase corrosion resistance of steel.
- To increase oxidation resistance of steel.
- To increase machinability of steel.

For example-

- a) Chromium in more than 12% in solid solution form is added in stainless steel as alloying element to improve corrosion resistance of steel.
- b) Tungsten is added around 18% in High speed steels to improve Red hardness property of steel.

f

(Any four correct points --  
- 04 Marks)

( correct points --- 04 Marks)



**Differentiate between Annealing and Normalising**

(Any four correct points --  
- 04 Marks)

Annealing	Normalising
1. Furnace cooling rate is used	1. Air cooling rate is used
2. Slower rate of cooling so less possibility of cracks and distortion in part	2. Comparatively faster rate of cooling possibility of cracks and distortion
3. More time is required	3. Less time is required
4. Coarse Pearlite structure is formed in steel	4. Fine pearlite structure is formed
5. Carried to remove stresses, refine grain homogenize structure in steel	5. Carried as final treatment to structure of steel
6. Temp Range $A_{c3} + 500^{\circ}C$ for hypo eutectoid Steels, $A_{c1} + 500^{\circ}C$ for eutectoid, hypereutectoid steels	6. Temp Range $A_{c3} + 500^{\circ}C$ for steels, $A_{c1} + 500^{\circ}C$ for eutectoid $A_{cm} + 500^{\circ}C$ for hypereutectoid
7. It relieves stress, refines grain size and improves machinability	7. It eliminates retained austenite and reduces hardness

---XX---