3rd SEM./MECH/AUTO/AERO/DIP IN MECH/MECH(PROD) /MECH(MAINT)/MECH(IND INTG)/MECH(SWITCH) - 2021(W)

Th3- Engineering Materials

Full Marks: 80 Time- 3 Hrs

Answer any **FIVE** Questions including **Q No. 1 & 2**
Figures in the right-hand margin indicates marks

1. Answer **ALL** questions 2 x 10
   a. Define Porosity.
   b. What is Mild Steel?
   c. Define unit cell.
   d. What is the significance of phase diagram?
   e. State two properties of spring materials.
   f. Why heat treatment is needed?
   g. State two characteristics of Duralumin.
   h. Define polymerization.
   i. Explain composite materials.
   j. What is the function of bearing?

2. Answer **Any SIX** Questions 5x6
   a. What is Spring? Discuss about different spring materials.
   b. Explain Frankel Defect with figure.
   c. Discuss about any two microconstituents of Iron & Steel.
   d. Classify Composite materials. Discuss about Dispersion-strengthened Composites.
   e. State the effects of adding Nickel and Molybdenum in steel as alloying elements.
   f. Discuss about different bearing materials.
   g Compare thermoplastic with thermosetting plastics.

3 Discus about any four types of mechanical properties of engineering materials. 10

4 Discuss about various properties of plastic. 10

5 What is Tool Steel? Classify it and state its properties with composition. 10

6 Draw Fe-C phase diagram. Explain about different phase transformations. 10

7 Explain about different crystal structures. 10

No-1 (a) Define porosity:

Ans:- porosity :- This is caused due to the presence of gases like O_2, N_2, H_2 entrapped by the cooling weld metal: porosity if present in large quantity would reduce the strength of the joint.

Cause:- Electrodes coating such as cellulose which is source of H_2 gas, dampness, dirty base metal, high speed welding, too raping cooling of the weld, bad welding techinique etc.

(b) what is mild Steel?

Mild Steel is a type of carbon steel with a low amount of carbon. It is also known as 'Low carbon steel'. Although range very depending on the source, the amount of carbon typically found in mild steel is 0.05% to 0.25% by weight.

Mild Steel is typically more ductile, machinable and weldable than high carbon and other steel.

(C) Define unit cell?

Ans:- unit cell is the smallest 3D portion of a complete space lattice which when repeated over and again in different direction produces the complete space lattice.

→ The dimensions along the three edges a, b and c, which may or may not be mutually perpendicular to each other.

→ The angle between the edges b and c is α, between a and c is β and between a and b is γ. Therefore a unit cell is characterized by six parameters a, b, c, α, β and γ.

(d) What is the Significance of phase diagram?

Ans:- phase diagrams are important for a Metallurgist, as they provide relationship between phases in a system as a function of temperature, pressure and composition. The developement of micro structure of an alloy of a perticular composition at different temperature is clearly depicted by a phase diagram. The phase also providing information on melting, casting and recrystallization of alloys.

(e) State two properties of Sprong materials.

Ans (i) High elastic limit and modulus of elasticity.

(ii) High fatigue and creep Strength.

(f) Why heat treatment is needed?

Ans- Its purpose is to change a mechanical property or combination of mechanical properties so that the metal will be more useful. Serviceable, and safe for a definite purpose. By heat treatment, a metal can be made harder, stronger, and more resistance to impact, heat treatment can also make a metal softer and more ductile.

(g) State two characteristics of Duralumin.

Ans (i) It is light weighted, tough, highly ductile, easyly castable, good conductor of heat and electricity and corrosion resistant.

(ii) It can easily be worked as it possesses high machinability.

(iii) Its tensile Strength can be raised up to 2000 kg/cm² without affecting ductility.

(h) Define polymerization.

Ans- polymerization is a process in which very small molecules, called monomers, combine chemically with each other to produce a very large chain like molecule called a polymer.

(i) Explain Composite materials.

Ans:(i) It contains two or more physically distinct and Mechanic-cally separable materials

(ii) It is made by dispersing one material in the other in a controlled way to achieve optimum properties.

(iii) The properties of the composite are superior and possibly unique in some specific respects to the properties of individual components.

(j) What is the function of bearing?

Ans:→ The main function of a ~~road~~ rotating shaft is to transmit power from one end of the line to the other.

→ It needs a good support to ensure stability and friction-less rotation. The support for the shaft is known as "bearing".

→ The shaft has a "running fit" in a bearing. All bearing are provided some lubrication arrangement to reduce friction between shaft and bearing.

No-2 What is spring? Discuss about different spring materials.?→

Ans:→ Spring is a elastic member whose function is to deform under load. and it regain it's original shape when the load is removed.

→ Spring used as shock absorbers.

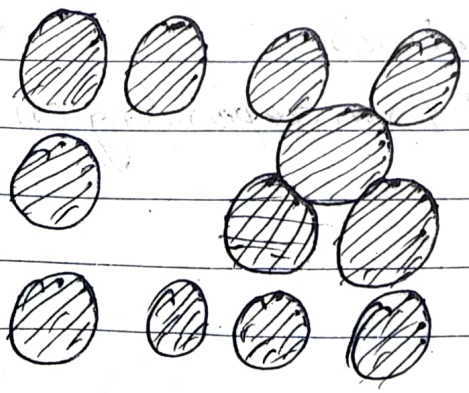
→ It can take any shape and form depending on its application

(b) Explain frankel defect with figure.

Ans:- frankel Defect:- An ion dislocated from the lattice into an interstitial site is called frankel-defect. The interstitialcies and frankel defects are less on number than vacancies and schottky defects, because additional energy is required to force the atom into the new position.

→ When an ionic crystal does not correspond to exact stoichiometric formula defect structures are produced. Such defect structures have an appreciable concentration of point imperfections.

→ The presence of a point imperfection introduces distortions in the crystals.



frenkel defect

(c) Discuss about any two microconstituent of Iron & steel.

Ans: Some of the micro constituent of Iron and Steel are Austenite, ferrite, Cementide, pearlete, Bainite. Martenite, Troostite, Sorbite and Ledeburite.

Ferrite:- It is a BCC Iron phase with very limited Solubility of carbon. The Solubility of carbon in ferrite is 0.08% at 723°C. ferrite doesnot hardden when cooled rapidly, It is very soft and high magnetic. At room temperature ferrite contains maximum 0.0025% only.

Austenite:- (γ- Iron)

It is Solid Solution of ferrite iron carbide in gamma iron which is formed when steel contains carbon upto 1.8% at 1130°c. On cooling below 723°C it starts transforming in to pearlite and ferrite. Austenite is non magnetic and soft. It exists in fcc crystal structure.

(d) classify composite materials. Discuss about dispersion strengthened Composites.

Composite Material: A composite material is a combination of two or more material having compositional variations and depicting properties distinctively different from those of the individual materials of the Composite. The composite material is generally better than any of the individual Components as regards their Strength, heat resistance and Stiffness

(e) State the effects of adding nickel and molybdenum in steel as alloying elements.

Ans:- By adding Molybdenum in steel as alloying element. It increase the strength, hardness, hardenability and toughness, as well as creep resistance and strength at elevated temperature. It improve machinability and resistance to corrosion and it intensifies the effect of other alloying element.

By adding Nickel, it increase strength and hardness without sacrificing ductility and toughness. It also increase the resistance to corrosion and scaling at elevated temperature when introduced in suitable quantities as high-chromium (Stainless) steel.

(f) Discuss about different bearing materials.

Ans:- Copper base bearing material :-

Cu	80 %	85 %
Sn	10 %	15 %
Pb	10 %	—

property :- Tensile strength of the range of 220 - 280 MPa

(ii) Elongation in 5cm length of 2 % to 10 %

use :- Copper based bearing material are employed for making bearing required to resist heavier pressure such as railway, locomotive side valve, bearing for turn tables etc.

Ton :- Sn - 88 %, Cu - 4 %, Sb - 8 %.

Lead based :- Pb - 75 %, Sn - 10 %, Sb - 15.

Bronze is the one of the oldest known as bearing Material.

(g) Compare thermoplastic with thermosetting plastics

Thermoplastic	Thermosetting plastics
(i) Thermoplastic can be synthesized by the process called addition of polymer.	(i) Thermosetting plastics are synthesized by condensation polymerization.
(ii) Thermoplastics have secondary bond between molecular chain.	(ii) Thermosetting plastics have have high melting point and tensile strength.
(iii) Thermoplastics have low melting points and low tensile strength.	(iv) Thermosetting plastic is high in molecular weight.
(iv) Thermoplastics is lower in molecular weight, compared to thermosetting plastic.	

of Materials :-

(1) Strength (2) Elasticity (3) plasticity (4) Ductility (5) Malleability (6) Brittleness (7) Hardness (8) Toughness (9) Stiffness (10) Resilience (11) Creep (12) Fatigue (13) Impact Strength (14) Wear Resistance.

1:- Strength :- Strength of a ~~mechanical~~ material has been defined as its ability to resist the action of an external force without breaking. It is most important property of a material from the mechanical point of view, which represent the ability of material to resist internal force or Stress.

(2) plasticity :- It is the property of material which enables the formation of permanent deformation.
Ex :- clay, lead.

(3) Stiffness :- It is the property of material which enables it to resist deformation, Modulus of elasticity is measure of Stiffness.

(4) Elasticity :- It is the property of material which enables it to regain its original Shape after deformation within the elastic limit. This property is desirable in materials used in tool and ~~steel~~ Machines.

Ex :- Steel, Rubber.

No-4 Discuss about various properties of plastic.

Ans:- → Light weight with a high strength-to-weight ratio.
→ can be manufactured inexpensively and mass produced.
→ Water resistant.
→ Shock resistant.
→ Thermally and electrically insulating.
→ Dimensional stability.
→ chemical Resistance.
→ plastics, generally, have low ductile and hence plastic structural member may fail without prior warning.
→ All operation like drilling, sawing, punching, clamping etc. are carried out easily on plastic just like wood.
→ The plastics have low thermal conductivity and therefore formed or expanded varieties of plastics are used as thermal insulator.

No-5 What is Tool Steel? classify it and state its properties with Composition.

Ans:- Tool Steel:- Steel used to manufacture cutting tools for lathe, milling, broaching machines etc. is known as tool steel. The tool steel material possesses hot hardness, wear resistance, toughness etc. properties for ideal cutting

Types of Tool Steel:-

(i) Carbon Tool Steel:- These are characterised by the low stability of the super-cooled austenite. They have a high critical cooling and low hardenability. These material are recomended for small size tools.

Ex:- Files, Core drills, Short reamers.

(ii) High carbon Steel:-
These types of tool Steel contain carbon close to plain carbon Steel but in addition there is say upto 5%. alloy content consisting of tungsten, molybdenum, chromium and vanadium etc.

(iii) High Speed Tool Steel:-
HSS are obtained by alloying tungsten, chromium, vanadium, cobalt and molybdenum with Steel. This alloying produces metal which remain hard at temperature at which normal Steel becomes quite soft. These are -
(a) 18-4-1 HSS (W = 18%, Cr = 4%. V = 1%)
(b) Cobalt HSS (Co = 2-15%. W = 20%., Cr. 4%., V = 2%.)
(c) Molybdenum HSS (Mo = 6%. W = 6%. Cr, 4%., V = 2%.)

Temperature ↑

Q.6b Draw fe-c phase diagram. Explain about different phase transformations.

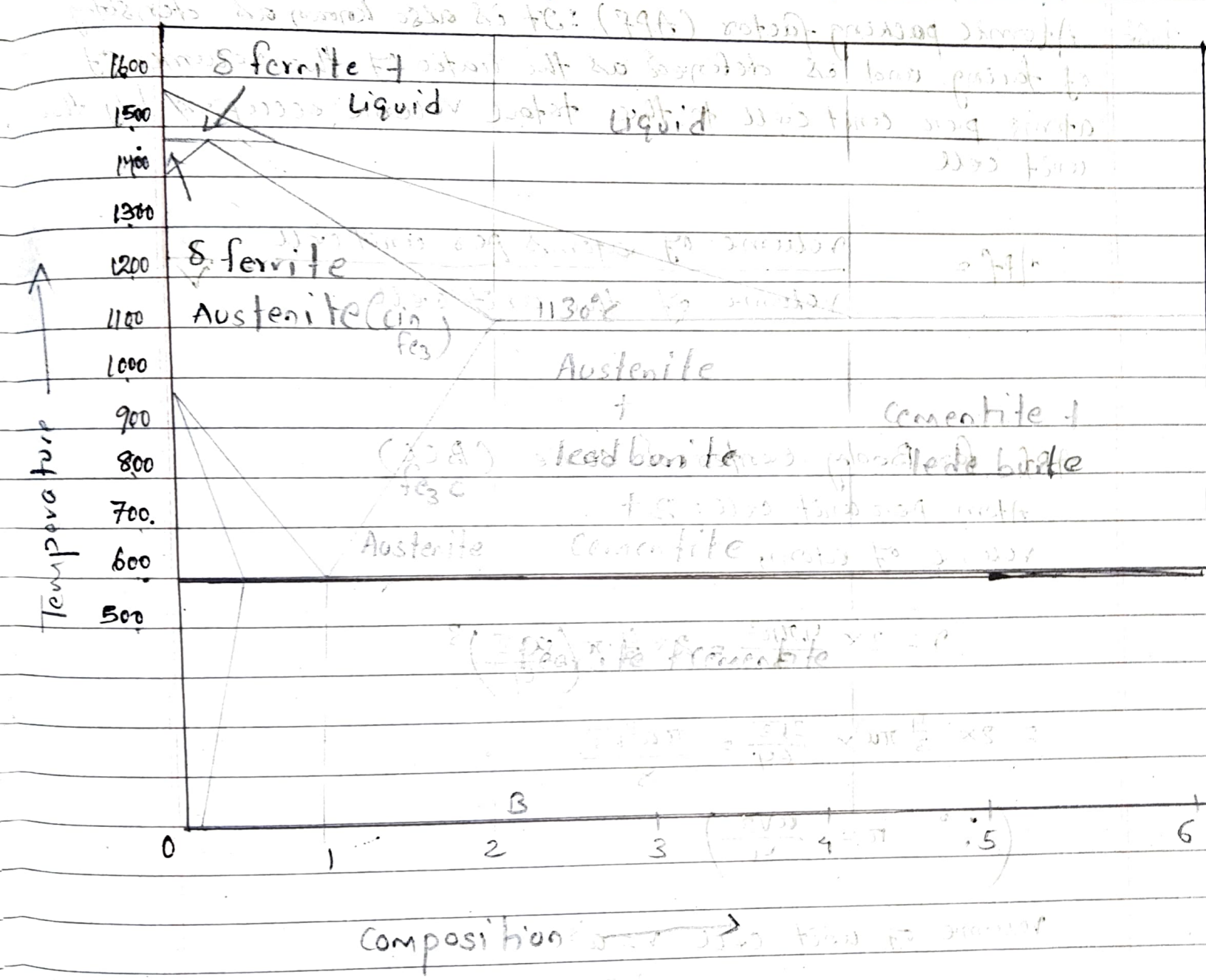
1- Ferrite:- Iron which contains little or no carbon is called ferrite. It is very soft and ductile and known as alpha iron by the metallurgist.

2- Cementite:- This is define as carbide iron (Fe_3C) which is extremely hard, being harder than ordinary hardened Steel or glass.

3- Pearlite:- pearlite is the name given to mixture about 87.5% ferrite and 12.5% cementite.

(4) Martensite:- It is hard brittle mass of fibrous no needle like structures and is the chief constituent of hardened steel.

(5) Austenite:- It is a Solid Solution of iron-carbon which is stable only within a particular range of composition and temperature, and is non-magnetic.


1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
Temperature
δ ferrite + Liquid
δ ferrite
Austenite (+ Fe3C)
1130°C
Austenite
+
Cementite
Ledeburite
Austenite
Cementite
B
0
1
2
3
4
5
6
Composition

07 Explain about different crystal structures.

Ans: Atomic packing factor (APf): It is also known as density of facing and is defined as the ratio of the volume of atoms per unit cell to the total volume occupies by the unit cell

$$Apf = \frac{\text{volume of atoms per unit cell}}{\text{volume of the unit cell}} = \frac{v}{V}$$

Apf for Body centered cube (BCC)

Atom per unit cell = 2

volume of atom,

$$r = 2 \times \frac{4\pi r^3}{3} = 2 \times \frac{4}{3}\pi\left(\frac{a\sqrt{3}}{4}\right)^3$$

$$= 2 \times \frac{4}{3}\pi a^3 \times \frac{3\sqrt{3}}{64} = \frac{\pi a^3\sqrt{3}}{8}$$

$$\left(\because r = \frac{a\sqrt{3}}{4}\right)$$

volume of unit cell $V = a^3$

$$\therefore (Apf)_{Bcc} = \frac{v}{V} = \frac{\frac{\pi a^3\sqrt{3}}{8}}{a^3} = \frac{\pi\sqrt{3}}{8} = 0.68.$$

Apf for face centered cube (fcc)

Atom per unit cell = 4

volume of 4 atoms $= 4 \times \frac{4}{3}\pi r^3$

$$= 4 \times \frac{4}{3}\pi\left(\frac{a\sqrt{2}}{4}\right)^2 = \frac{\pi a^3\sqrt{2}}{6}$$

$$\left(\because r = \frac{a\sqrt{2}}{4}\right)$$

volume of unit cell, $V = a^3$

$$(Apf)_{fcc} = \frac{v}{V} = \frac{\pi a^3\sqrt{2}}{6} = \frac{\pi\sqrt{2}}{6} = 0.74.$$