I.A. 2022 sub-EMT (th-3) Branch –Mechanical Sem- 3rd

1.A.What do you meant by Composite Material?

Composite : (i) Composite materials are mixture of two or more different materials that are mechanically or metallurgical bonded together.

(ii) Usually the components do not dissolve in each other and can be physically identify by an interface between the component

Ex: fiber glass, R.C.C.

1.b**.Define Ductility & Malleability.**

Ductility

The capacity of a material to undergo deformation under tension without rupture.

Malleability

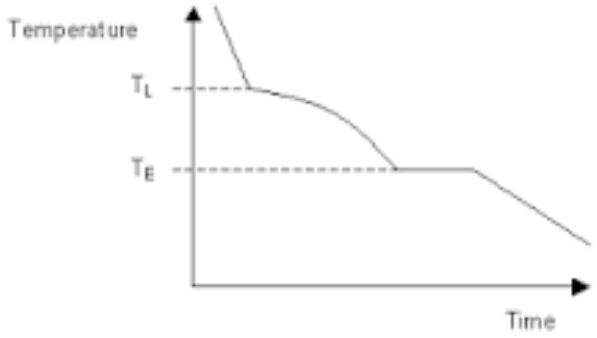
The capacity of a material to withstand deformation under compression without rupture.

1.c. **What is Stainless steel?**

Stainless Steel: – When 11.5% or more chromium is added to iron, a thin surface of chromium oxide forms on the iron surface exposed to air or presence of air.

– This chromium oxide surface acts as a barrier to retard oxidation, ,rust, stains &corrosion. – As this steel cannot be stained easily It is called stainless steel.

1.d.Draw the cooling curve of Binary eutectic system.



1.e. What is Austenite?Write its properties.

Austenite (i) It is the solid solution of carbon in ɣ-iron.

(ii) The maximum solid solubility carbon in ɣ-iron is 2% at 11300C.

(iii) It is a soft, ductile & Non-magnetic in nature.

(iv) It has FCC crystal structure.

(v) It is stable above 7230C.

1.f.What is Allotropic metal?Give example.

Allotropic Metal

If a metal exist in more than one lattice structure depending upon temperature then it is called Allotropic metal.

Example –Iron

1.g.What are the objectives of phase diagram?

Objectives of phase diagram

i.it establishs acorelation between the microstructure & properties of steel.

ii.it provides basics for understanding the principle of heat treatment.

1.h.Write properties of Tool Steel.

Tool Steel: – Tool & Die steels may be defined as special steel which have been developed to form to cut or otherwise change the shape of material into finished or semi finished product. Properties of tool steel: – Good toughness – Good wear resistance – Very good machine ability – A definite hardening temperature – Little risk of cracking – A definite cooling rate.

2.a.What are the effects of Ni,Cr,V,Mn,Mo as an alloying elements?

Effects of alloying elements: –

Nickel:

(i) Increases toughness & resistance to impact.
(ii) (ii) Strengthen steels.
(iii) (iii) Lowers the critical temperature of steel.
(iv) (iv) Widen the range of heat treatment.
(v) (v) Does not unite with carbon
(vi) . (vi) Less distortion in quenching

Chromium:

Chromium joints with carbon to form chromium carbides. Thus adds depth harden ability with improve resistance to abrasion & wear

Vanadium:

– Promotes fine grains in steel.

– Increases harden ability when dissolved.

– Imparts strength & toughness to the steel

Manganese:

(i) It increases strength & hardness of the material
(ii) It resists brittleness of the material.
(iii) Lowers ductility & weld ability If it is present in 5% of carbon contained in a steel.

Molybdenum:

– It promotes harden ability of steel

– It makes steel fine grained.

– It makes steel tough of at various level

– It resists brittleness of steel.

– Enhances corrosion resistance in stainless steel

. – Increase tensile & creep strength at high temperature

2.b.What are the factors to be considered during selection of materials for engineering purposes?

Factors affecting the selection of materials for engineering application : –

Following factors are affect the selection of material for engineering purpose directly & indirectly. – (i) Properties of material (ii) Environmental condition (iii) Availability (iv) Disposability (v) Economic factors (vi) Physical attributes (vii) Performance Requirement (viii) Material reliability (ix) Safety

Performance Requirement: – The material of which a part is manufactured must be capable of performing its function without failure

. – For example - a component to be used in the furnace must have been of that material which can withstand high temperature.

Material Reliability: – A material a given application must be reliable. Simply states that reliability is the degree of probability that a product and the material of which It is made will remain stable enough to function in service without failure.

Safety: – a material must perform its function otherwise the failure of the product made out of it may be catastrophic as in air planes, turbines etc.

Properties of materials : – Property of a material is a factor that influences qualitatively or quantitatively the response of a given material to the applied constraints like force, temperature etc. – engineering properties of the materials are classified into different categories :

Mechanical property : Mechanical properties give us information about the behavior of the material under the action of external force. Ex- Strength, ductility, brittleness, creep, fatigue. Impact resistance etc.

Electrical property : – Electrical property gives up information about the behavior of material when electric current flows through them. Ex- Restively, conductivity, dielectric strength etc.

Thermal Properties : Thermal property gives us information about the behaviors of the material under the action of heat. Ex- Specific heat, thermal conductivity melting point thermal expansion.

Magnetic property : Magnetic property gives us information about the behavior of the material under the action of magnetic field. Ex- Permeability, Hysteresis etc.

Physical property of a material : – Physical properties are employed to describe a material under condition in which external forces are not concerned. – Physical property includes

. Dimensions of the material - Dimensions implies that length, breadth height, diameter etc of rectangular,square ,circular or any other section.

(ii) Porosity - A material is said to be porous. If it has poros within it. True porosity =Total pore volume/ Bulk volume

(iv) Structure: Structure means geometrical shapes of material or components, such as circular rectangular etc.

(v) density : The density is the weight or mass of unit volume of material expressed in metric units. Chemical property: Most of the engineering materials when they come in contact with other substances, with which they can react, tend to suffer chemical deterioration. This necessitates the study of chemical properties of material. – Some of the

(vi) chemical properties are :

(i) Corrosion resistance: It is the loss of material by chemical reaction with the environment. Corrosion degrades material properties and reduced economic value of the material.

(2) Chemical composition

(3) Acidity Short questions & long questions 1-Write down the mechanical properties of material.

2.c.Draw the cooling curve for pure iron & explain it.

Iron allotropy: –

Iron is relatively soft & ductile in nature. Iron has meting point of 1539 0C.

– Iron is allotropy metal which means it exists more than one types of lattice structure (BCC/ FCC) Depending upon temperature.

– In normal room temperature iron is BCC in lattice arrangement where as at 9080C. it changes to FCC & then at 14030C. It backs to BCC & again vice versa.

– Another change occurs at about 770˚C (Curie point) at which the magnetic property of iron disappears& It becomes non-magnetic.

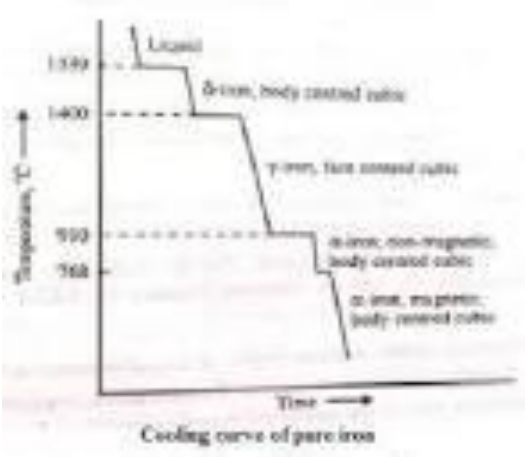
– The iron remains Non-magnetic until the temperature drops back below the Curie point upon which it's magnetic property reappear.

– In the figure iron is molted above 15390C & it solidify in the BCC б-form.

– On further cooling at 14000C a phase change occur & the atoms rearrange themselves into ᵞ-form which is FCC. Structure and non magnetic in nature.

– On steel further cooling at 9100C another phase change occurs from FCC Non-magnetic ᵞ iron to BCC Non magnetic α iron.

– Finally at 7680C the α iron BCC. Becomes magnetic without change in lattice structure



Cooling curve of pure iron

2.d. With a neat sketch of Fe-c phase diagram explain different Microconstituent of steel & cast iron.

(a) Alpha (α)ferrite:

(i) Ferrite is the name given to the interstitial solid solution of carbon in α-ferrite.

(ii) It has BCC crystal structure.

(iii) The solubility of carbon in α-ferrite is 0.008% at room temperature which increases 0.025% at 723 C.

(iv) It is the softest structure & ductile in nature that appears in iron carbon diagram.

(v) It is strongly ferromagnetic up to 7680C after which it becomes Non-Magnetic in Nature. This temperature is called curie temperature

(b) Austenite or (ˠ) iron: (i) It is the solid solution of carbon in ˠ-iron.

(ii) The maximum solid solubility carbon in ˠ-iron is 2% at 11300C.

(iii) It is a soft, ductile & Non-magnetic in nature.

(iv) It has FCC crystal structure.

(v) It is stable above 7230C.

(**c) б- Ferrite** (i) It is an interstitial solid solution in carbon in б- iron.

(ii) It is stable between the temperature 14000C to 15390C..

(iii) The maximum solubility of carbon is б-iron is 0.012% at 14970C.

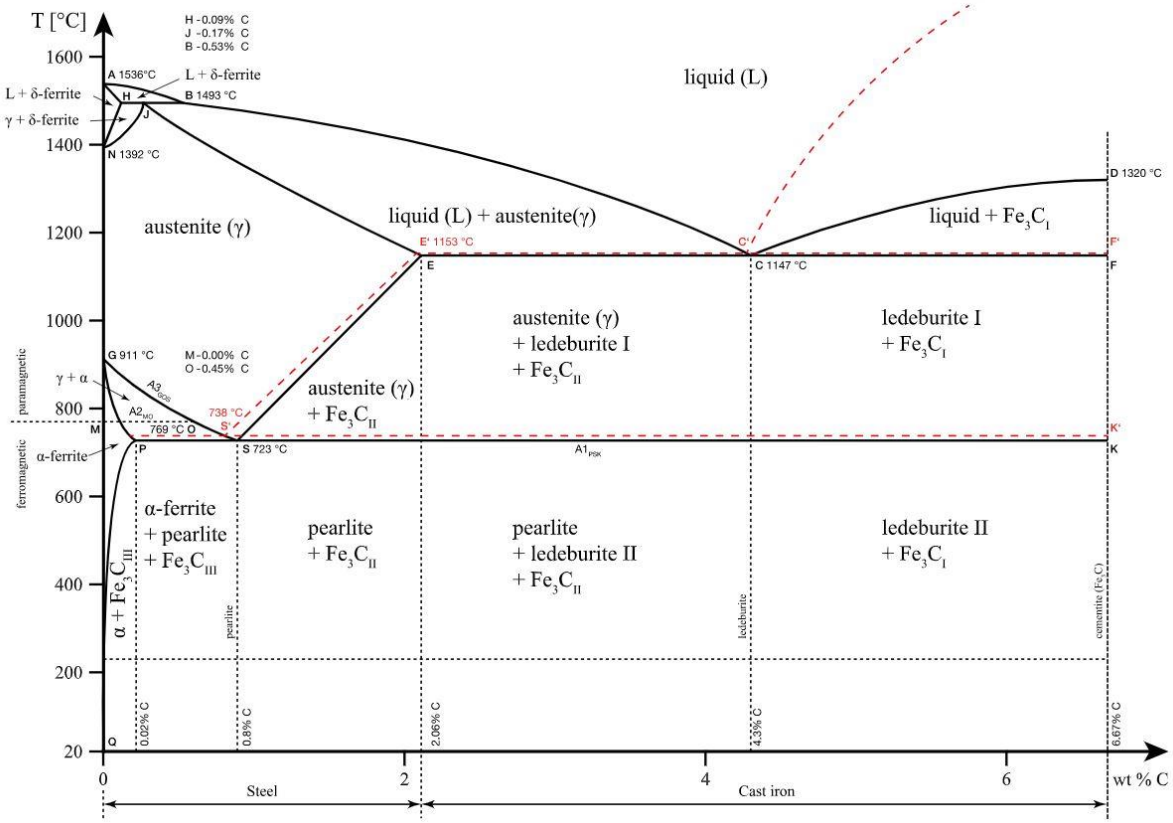
(iv) It has BCC crystal structure.

(d) Cementite : (Fe3C) (i) It is an intermetalic compound of iron & carbon.

(ii) It has a fixed carbon contained that is 6.67% by weight

(iii) It has a complex crystal structure having 12 iron atoms & 4 carbon atoms in a unit cell that is 3:1 ratio.

(iv) It is hard & brittle in nature & having low tensile strength. (v) It is the hardest structure that appears in iron- carbon diagram.


T [°C]
1600
1400
1200
1000
800
600
400
200
20
H -0.09% C
J -0.17% C
B -0.53% C
A 1536°C
L + δ-ferrite
H
B 1493 °C
L + δ-ferrite
γ + δ-ferrite
J
N 1392 °C
liquid (L)
D 1320 °C
austenite (γ)
liquid (L) + austenite(γ)
liquid + Fe3CI
E' 1153 °C
C'
F'
E
C 1147 °C
F
austenite (γ)
+ ledeburite I
+ Fe3CII
ledeburite I
+ Fe3CI
G 911 °C
M -0.00% C
O -0.45% C
paramagnetic
γ + α
A3
A2
738 °C
S'
austenite (γ)
+ Fe3CII
M
769 °C
O
K'
ferromagnetic
α-ferrite
P
S 723 °C
A1
K
α-ferrite
+ pearlite
+ Fe3CIII
pearlite
+ Fe3CII
pearlite
+ ledeburite II
+ Fe3CII
ledeburite II
+ Fe3CI
α + Fe3CIII
pearlite
ledeburite
cementite (Fe3C)
Q
0.02% C
0.8% C
2.06% C
4.3% C
6.67% C
0
2
4
6
wt % C
Steel
Cast iron